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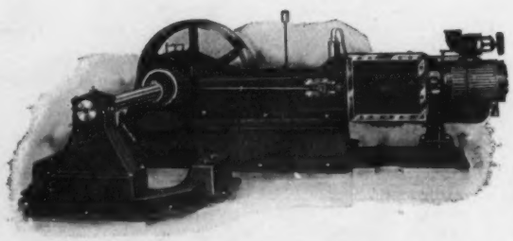

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JOURNAL OF ELECTRICITY
POWER AND GAS

Devoted to the Conversion, Transmission and Distribution of Energy

VOLUME XXIII | SAN FRANCISCO, SEPTEMBER 18, 1909 | NUMBER 12

JOINT CONVENTION AT SEATTLE

Northwest Electric Light and Power Association

Seattle Section A. I. E. E.

An important gathering of electrical engineers convened at Seattle, Washington, last week at the joint convention of the Northwest Electric Light & Power Association and the Seattle Section of the American Institute of Electrical Engineers. The convention was well attended by representatives of the central stations of the Northwest and was honored by the presence of Ralph W. Pope, the national secretary of the American Institute of Electrical Engineers, Charles F. Scott, past president of the Institute, and Vice-President Paul M. Lincoln of Pittsburg, Pa. The sessions were divided into two parts, the technical, under the auspices of the Seattle Section of the Institute, and the commercial, under the direction of the Northwest Electric Light & Power Association. Several papers of vital interest were read and ably

Front Row—Ralph W. Pope, Frank H. Gale, Arthur Gunn, Norwood W. Brockett, C. W. McNary, H. L. Bleecker, J. E. Wickstrom, W. S. Hoskins, W. O. Roe. Second Row—M. D. Spencer, F. Gates, Douglas Allmond, J. H. Whittaker, Eugene Enloe, F. H. Lauzon, C. E. Keihl, George Cooley, H. Shaw, W. H. Schrader. Third Row—Al McMickan, S. A. Hoag, Chester Turley, F. S. Jacobsen, H. R. Morgan, C. Cox, F. E. Boyd, A. G. Jones, J. E. Hill, A. Whittaker, C. E. Hickey. Fourth Row—F. F. Barbour, E. W. Sherwood, E. A. Hunt, R. M. Armes, J. Coots, E. W. Rhodes, E. E. Goss, H. P. Andrews. Fifth Row—E. A. Bradner, E. J. Cash, B. F. McGee, W. S. Manning, M. C. Osborn, A. M. Chitty, D. O. McKissick, J. M. Kinkaid.

discussed; that of Protection of Electrical Equipment by P. M. Lincoln, and the Trend of Electrical Development by C. F. Scott, evoking particular comment. The suggestion of the electrical vehicle as an important help to load factor was especially well received.

The convention was called to order at the Fine Arts Building of the A.-Y.-P. Exposition at 10:40 a. m., Tuesday, September 7, by President Arthur Gunn. In the unavoidable absence of Mayor John F. Miller of Seattle, President Gunn welcomed the delegates to both the technical and commercial session.

Past President C. F. Scott of the A. I. E. E., in response, commended the Seattle Section on its energy and growth, which suggested unexpected section possibilities to those at the headquarters in New York. Mr. Scott also expressed pleasure and surprise at the remarkable electrical development in the Northwest since his last visit, and prophesied a great future for the electrical industry of the Northwest.

Mr. O. B. Coldwell of Portland, speaking for the Northwest Electric Light & Power Association, emphasized the advantages of joint sessions with the A. I. E. E., including interchange of ideas between the technical and the commercial branches of the business. In concluding, he called attention to the excellent entertainment provided by the committee, and extended a cordial invitation to all to enjoy them.

President Gunn then called Mr. John S. Harisberger to the chair for the technical session. Mr. Harisberger introduced Mr. Ralph W. Pope, who gave an address on the Administration of Institute Affairs, in which he briefly referred to his first view of Seattle from the deck of the steamer California, which landed at Yesler's Wharf in the spring of 1865. Mr. Pope was then returning from his British Columbia exploration for the route of the Collins Overland Telegraph Line.

He stated that one of the principal reasons why the Institute was organized in 1884 with headquarters in New York was that the American Electrical Society, which had practically failed a few years earlier was founded upon district organization, the central office being in Chicago. Owing to the practical limitations of the art of telegraph engineering, there was not sufficient interest shown to give proper support to the association, and it gradually went out of existence, with the single exception of the New York Electrical Society, which had kept up its organization continuously. The idea of organizing sections was the natural outcome of national expansion, but prior to the administration of President Scott, their establishment had not been encouraged. Seven years' experience appeared to have justified the movement, as most of the sections had continued their work, and were active factors in the growth and strength of the Institute. As an instance, he mentioned the fact that but for the activity of the Seattle Section, his official tour would probably not have been authorized, at least during the present year.

Mr. Pope also referred to the important and exacting duties of the Board of Examiners in recommending transfers to the grade of membership. He said that he had met with the Board at nearly every session for twenty years and while mistakes may have been made, either in being too liberal or too rigid in certain cases, he thought there had been very few. While the constitution appeared to be quite definite in its requirements, the Board was frequently called upon to determine the character of the electrical engineering experience. What appeared to be very important work in one section of the country might not reach the proper standard according to the views of the Board. Applicants were also frequently careless in preparing their records, which was in itself a criterion of an engineer's work. Many graduates of technical institutions were also of the opinion that their term of experience began immediately upon the commencement of practical work, which was seldom the case.

Mr. Pope then called attention to the organization of his office staff, which consisted of an assistant secretary, editor, chief clerk, section and transfer clerk, stenographer and proofreader, cataloguer, application clerk, shipping clerk, filing clerk, messenger and two library assistants, making a total of thirteen, including the secretary. The office force was so organized that the absence of the secretary by reason of such a trip as he was now taking, would not interfere with the efficiency of the management.

Other papers read at the technical session included "Modern Central Telephone Stations" by C. E. Flager of the Pacific Telephone and Telegraph Co.; "Protection of Electrical Equipment" by Paul M. Lincoln of the Westinghouse Electric Mfg. Co.; "Illuminating Engineering for the Central Station," by W. L. Hamilton of the Portland Railway, Light & Power Co.; "High Efficiency Lamps," by W. G. Sherwood of the General Electric Co.; "The Trend in Electrical Development," by Charles F. Scott of the Westinghouse Electric Mfg. Co.

The first Commercial Session was held on Wednesday morning. M. C. Osborn, chairman of the Rate Committee made a brief report, citing the rates now in force among the consumers of the Washington Water Power Company, as the result of the analyses of something like 100,000 accounts. He showed how the residential rate was figured to be the same per kilowatt as the commercial rate, taking as a basis 60 per cent of connected load as a "readiness to serve." The commercial rate with load factor and block system of discounts for quantity consumers would meet the requirements of all classes of consumers. Following is the rate schedule:

Residential Rates.

10 cents per kilowatt hours for first 20 kilowatts per month.
9 cents per kilowatt hours for second 20 kilowatts per month.
8 cents per kilowatt hours for third 20 kilowatts per month.
5 cents per kilowatt hours for excess over 60 k. w. per month.
Minimum, $1.00 charge per month.

Commercial Rate.

$3.00 per kilowatt per month charge for "readiness to serve" and 5 cents per kilowatt hour additional for all electrical energy consumed. Load factor discount, 1 per cent for each per cent of load factor over 25 per cent. Quantity discount: First $50, net; second $50 or part thereof, 10 per cent discount; second $100 or part thereof, 20 per cent discount; third $100 or part, 30 per cent; fourth $100 or part, 40 per cent; excess over $400, 50 per cent discount.

The report of the committee on uniform method of accounting was presented by Frank Dabney, chairman.

He quoted at length from the report of similar committee of the National Electric Light Association, giving various schemes for uniform accounting. He suggested that the Northwest Association wait until this was worked out and proved practical.

Arthur Gunn, in the course of his presidential address, spoke of the good work accomplished by the association and commended the endeavors of the various officers and members. Later he read a paper on "Employers' Liability and Employees' Indemnity," in which he advocated a law that would permit a contract for indemnity between employer and employee with stated indemnities for every class of injury. He stated that such a law would do away with costly litigation and it would be better for both employers and employees. He called attention to the fact that the United States is the only civilized nation having no such law.

The report of Treasurer N. W. Brockett showed that all debts had been paid and there remained on hand $1015.88.

ARTHUR GUNN.
Re-elected President N. W. Electric Lt. & Power Ass'n.

Election of officers now being in order, the nominating committee presented for president, Arthur Gunn; vice-president for Oregon, H. V. Gates of Heppner; vice-president for Idaho, D. C. McKissick, Wallace, Idaho; executive committee—O. B. Coldwell, Portland, Ore., C. H. McNary, Clarkston, Wash., and Douglas Allmond, Anacortes, Wash. All were unanimously elected.

The constitution was amended so as to permit reelection of the president and to allow the convention to be called at such time and at such place as the executive committee may determine.

A vote of thanks was unanimously given to N. W. Brockett for his able and faithful work as secretary and treasurer during the past year. Mr. Brockett was reappointed by President Gunn for the coming year. It was suggested to the executive committee that the convention be held next year on board a steamer chartered for a trip to Alaska waters to extend over a period of one week. The matter is now under consideration.

PROTECTION OF ELECTRICAL EQUIPMENT.[1]

BY P. M. LINCOLN.

The question which I wish to discuss in the following is that of the protection of electrical apparatus and transmission lines from the danger of breakdown to which such apparatus is subjected by electrical "surges." The most frequent and severe source of electrical surges is lightning. There are other causes, arising from operation of transmission line and the electrical apparatus that goes with it to make up a complete plant. For instance, switching, particularly on the high tension side, may give rise to surges. Also grounding of high tension transmission lines particularly if the ground be an arcing one such, for instance, as would occur when the limb of a green tree comes occasionally into contact with one of the conductors of the line. Also a short circuit on the transmission line or other electrical apparatus may give rise to an electrical surge.

The question which I wish particularly to discuss in this paper is, therefore, the manner in which such surges may arise and the best protection to supply in order to prevent them from damaging either the apparatus or service. I do not expect in this discussion to bring out anything new. The most that I could possibly expect is to bring a new viewpoint to some who are interested in long distance power transmission and the protection of transmission circuits from damage and interruption.

What is meant by the term "surge"? This is a fair question and should have a straightforward answer. If this question were to be asked of Steinmetz he would fill pages with differential equations and long ess signs of integration and finally give an answer (as he has already done), in the form of mathematical formula. Such an answer, although it tells the story, is unfortunately useless to the mind of the average long distance transmission line operator since it requires the mind of a trained mathematician to interpret such an answer as well as to make it.

For my own part I have found that a proper conception of the phenomenon of electrical surges can be much better conveyed to the mind by using an analogy. The use of a proper analogy conveys a concrete idea rather than an abstract one, and the mind can much more readily grasp the idea in that shape than when it is merely abstract ideas which must be always associated with such electrical terms as volts, ohms, henrys, microfarads, etc. Any analogy must be used carefully, since in many points of comparison it is apt to fail. If improperly used, it may lead to conclusions entirely wrong, but if properly applied it will lead the average mind to a much clearer conception of what is going on than can be obtained by any consideration of merely abstract quantities.

The following hydraulic analogy, in many respects, is similar to the electric circuit and I trust that its description will be of assistance to some in gaining an idea of an electric "surge."

Suppose we replace a 3-phase a. c. generator, transmission line and receiving apparatus with a hydraulic arrangement shown in Fig. 1. In this figure,

[1]Paper read at convention N. W. Electric Light and Power Association, Seattle, September 7, 8, 9, 1909.

"A" is the piston pump with the three pistons 120 degrees apart. "C" is a duplicate of pump "A," whereby the work done by "A" is transferred to "C" and "B" are pipes connecting "A" with "C." The likeness to an a. c. power transmission system is accentuated in our analogy by the fact that the water or other liquid in the system simply oscilates back and forth through the pipes "B" from generator pump "A" to motor pump "C." In order to endow this hydraulic system with the functions of an electric circuit we will have to imagine that the walls of pipes "B" are perfectly flexible—for instance to be made of pure India rubber. This introduces into our hydraulic system the analogy of static capacity in the electric system. If we imagine that water is to be used in the hydraulic analogy the weight or inertia of this water introduces into the hydraulic system the equivalent of inductance or reactance in the electric system. Since the water in passing back and forth will have certain losses due to friction against the walls of the pipe and pumps, the idea of ohmic resistance of the electric circuit is transferred to the hydraulic analogy.

If we wish to imagine the effect of increasing static capacity we might do so in our hydraulic analogy by imagining the walls of the pipe to become more flexible; for instance to be made of thinner walls of rubber. For a transmission line without capacity, we

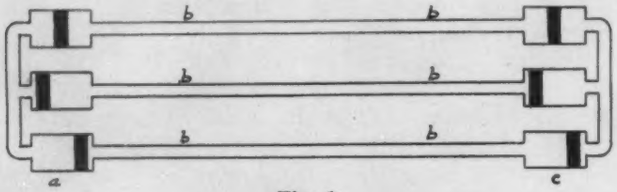

Fig. 1.

would have to substitute a hydraulic system with perfectly rigid and inflexible pipes. Increasing inductance or reactance may be represented in our analogy by increasing the weight and therefore the inertia of the liquid pumped; for instance by substituting mercury for water. Increasing electric resistance may be represented by smaller, rougher or longer pipes, thus increasing the frictional resistance. It is further necessary to assume that the volume of the pump cylinders is large compared to the volume of the pipes connecting the two pumps and to gain a proper idea we would have to imagine further that the speed of the pumps is slow, say one stroke per minute or so.

Now if we can keep our imaginations under proper control and can carry this hydraulic analogy in our minds we are prepared to investigate the nature of an electric surge by means of this analogy. Suppose we suddenly inject into one of the flexible pipes "B" at some point between pumps "A" and "C" an amount of liquid which will instantly swell the pipe at that point to some three or four times its normal diameter for a length of some eight or ten diameters. This would be analogous in the electric system to the effect of lightning. A cloud discharges in the neighborhood of a high tension transmission line. The area of the transmission line which has been covered by the cloud is relatively small. The discharge of that cloud releases in the transmission line a certain amount of static electricity in addition to the normal amount of current present due to the action of the generators and receiving apparatus. What happens next? It is much easier for the imagination to follow this in the analogy than in the actual transmission line. If the pipe is not strong enough the wall breaks—that is an insulator punctures or "slops over," and the accumulation of water, electricity—in part at least escapes. If the walls of the pipe are strong enough to stand the strain—that is if the insulators do not break down—a wave or surge begins to be propagated in both directions. The distended walls of the pipe bring their elastic force to bear upon the enclosed liquid and the accumulated "lump" of water begins to be dissipated in both directions. Inertia of the liquid together with the pressure on it from the elastic walls will cause it to assume successive forms which are probably very much like those shown in Fig. 2. The accumulation of liquid will become longer and thinner and it finally divides into two separate "lumps" as it travels from the point of disturbance in both directions. At the point of disturbance the tendency to break the walls is the maximum and this tendency becomes less and less as the wave or surge proceeds from the point of

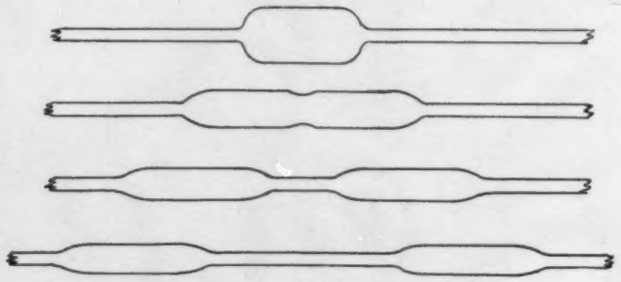

Fig. 2.

disturbance. However, should the surge encounter a weak place in the walls, a break may occur in some place comparatively remote from the point of disturbance.

Now, what happens when this wave or surge reaches the electrical apparatus at the ends of the line. For the purpose of considering this question, we would have to replace our pumps with something that will behave like a transformer or generator in an electric system. Now, generator and transformer windings have two important differences from an equal length of transmission line in that both the capacity and inductance per unit length are largely increased. In our hydraulic analogy the increase in capacity per unit length may be represented by imagining a much thinner walled pipe for the generator. The increase in inductance per unit length may be represented in the analogy by an increase in the specific gravity of the liquid—say by substituting mercury for water. I have endeavored to give a graphic representation of these modifications in Fig. 3.

B-1 is the transmission line with relatively heavy walls although still flexible and a light liquid contained therein, say water.

B-2 is the generator which has relatively thin but still perfectly, elastic walls containing a heavy liquid, say mercury.

When the wave or surge that has been started out

on the line B-1 reaches the point "P" that is the terminal of the generator or transformer, it is obvious that the following things will occur:

First—A part of the energy of the incoming wave will be reflected and will therefore travel back through the line B-1 from the point "P."

Second—The remainder will begin to travel through part B-2—the generator or transformer but the speed of its propagation will be very much reduced because the liquid being set into motion is very much heavier and also because the forces acting upon it through the elastic retaining walls are much smaller.

Third—The steepness of the wave front during its propagation through B-2 will be very much increased over that obtaining in B-1 on account of the action of the same forces as noted in the above paragraph.

I have allowed my own imagination rather free play and give in Figs. 4, 5, 6 and 7 my idea of how the wave will modify itself when being propogated from medium B-1 to medium B-2. Probably the most noteworthy modifications during this transfer of the disturbance from B-1 to B-2 is the abrupt increase in the steepness of the wave front. For instance, consider the points P-1 and P-2 in Fig. 5. At P-1 there is a tendency to burst the pipe, that is breakdown the insulation to ground; but there is also a heavy stress tending to break through from point P-1 to point P-2. Suppose that the portion B-2 of our pipe, instead of being straight as indicated by our diagram were to be coiled upon itself and that one complete coil took place in the distance from P-1 to P-2, then there would be a tendency for the liquid at point P-1 to break through the walls of the pipe into the nighboring coil at P-2. This is exactly what occurs in the electric system. An incoming surge, in penetrating the turns of electrical apparatus, causes an excessive voltage strain between adjacent turns. The momentary breakdown or snapping across of this surge from one turn to the next will do no particular damage unless such breakdown is followed by the dynamo current and an arc is thereby established. If this later event occurs then the break does tremendous damage. In my opinion, practically all of the failures in generators, transformers, etc., which can be traced directly to lighfning or other surges, are due to a breakdown between turns rather than to a break of the insulation from conductor to the ground. There is of course, due to the normal operation of the apparatus, an insulation strain from conductor to ground and also one between adjacent turns. A surge momentarily increases both of these strains. The strain and ground may be thereby increased 20 per cent, 50 per cent or perhaps 100 per cent or even somewhat more; the strain between turns may thereby be increased 20 **times, 50 times, 100 times** or even more. A surge therefore, throws a tremendously larger increase on the insulation between turns than it does on the insulation to ground. From certain observations that I have made, it is my opinion that the momentary strains between turns, particularly near the terminals of the apparatus may approximate, a considerable percentage of the terminal pressure. This is a danger in electrical apparatus which has not been sufficiently appreciated in the past.

It is evident that the protection of electrical apparatus from such dangers as are outlined in the above consists in:

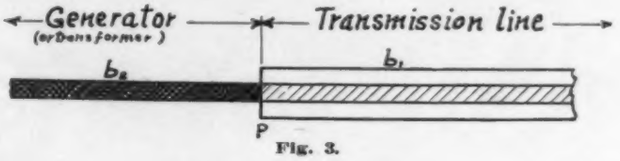

Fig. 3.

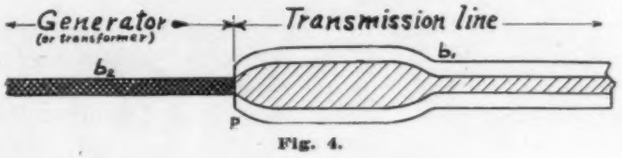

Fig. 4.

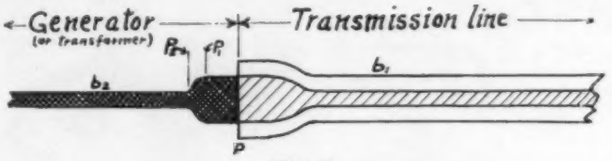

Fig. 5.

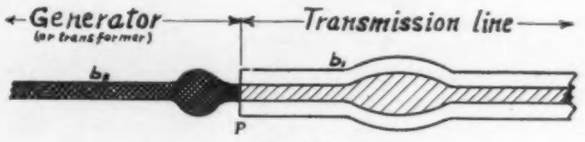

Fig. 6.

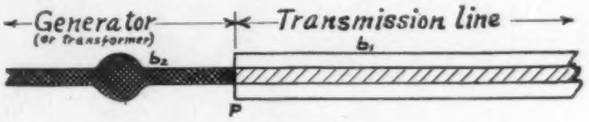

Fig. 7.

First—Making the apparatus so that it will stand large momentary voltages between turns. This consideration shows the great advantage possessed by transformers, particularly oil insulated, over generators. It is possible to insulate transformers between turns to a much higher degree than any generator can be, particularly where oil is used.

Second—Limiting by use of proper lightning arresters the size of the wave or surge that may enter the electrical apparatus. Reverting to the hydraulic analogy, if we should provide a hydraulic relief valve at the point "P," Fig. 5, it would have the effect of removing at least a part of the excess liquid at the instant the strong pressure on the walls occurs. If this relief valve were to be set so that it operate at pressure of say only 20 to 30 per cent above that caused by the pumps while in normal operation, then this relief valve would not affect the normal operation and would also limit a surge or wave entering part B-2 to an amount which could not exceed 20 or 30 per cent above normal pressure or voltage. This indicates the function of the ideal lightning arrester. It prevents any electrical surge which has a value of 20 to 30 per cent greater than normal voltage from entering the electrical apparatus. This is the utmost that any lightning arrester can do. The electrical

apparatus itself must be so designed that it will take care of an entering surge which is not more than 20 or 30 per cent above line voltage.

Reverting again to the hydraulic analogy suppose our relief valve has a relatively long discharge pipe of say 1-100th the area of the incoming pipe "B" in Fig. 1. The time during which the excess pressure exists at "P," Fig. 5, is relatively small. Such a pipe attached to the relief valve would be utterly unable to discharge a sufficient amount of the liquid to relieve the pressure. As a consequence the size of the surge entering part B-2 would be but little reduced by such a relief valve. This is analogous to what occurs with a lightning arrester having a large ohmic resistance in series with it for the purpose of preventing the dynamo current from following. This indicates in general why this type of arrester is inferior to the electrolytic. The electrolytic type of arrester, once broken down, has almost a zero resistance to ground and therefore allows the maximum possible reduction of the surge before it enters the electrical apparatus.

Another method of protection that has shown itself of considerable value both in theory and practice (as a protection from lightning) is the overhead grounded guard wire. The theory of this kind of protection is as follows:

Any conductor that is entirely enclosed or surrounded by another conductor cannot have induced thereon a static charge which originates from any action going on outside the surrounding conductor. For instance, a lead covered electric cable cannot be directly subjected to lightning disturbances because of the protection action of the surrounding lead sheathing. The overhead ground wire acts to a certain extent in the same manner. Although it does not entirely surround or enclose the high tension wires which it protects it does so partially and to the extent that it does enclose or surround the high tension wires it provides the same protection as does the lead sheath to the underground cable. In the electric transmission circuit the voltage of the charge which would otherwise be induced upon the transmission line is kept down by the presence of the guard wires.

Still another method of protecting high tension transmission lines is to ground the neutral of the lines. This grounding may be done either by connecting it solidly to the ground or by putting in a greater or less resistance between the neutral point and the ground. To just what extent this grounding of the neutral either completely or partially is of value is a mooted question among engineers. As I see it, the question of grounded neutral versus ungrounded may be considered from two view points; first, from the viewpoint of protection of the apparatus or equipment and second, from that of the protection of the service.

First—Protection to apparatus. The advantage in a solidly grounded neutral, so far as protection to apparatus is concerned is that the normal voltage to ground can under no conditions rise to more than about 58 per cent of the normal voltage between conductors. This advantage is, of course of the utmost importance when considering insulation strengths to ground of the various apparatus involved.

On the other hand, the disadvantages of a solidly grounded neutral is that every ground which occurs develops immediately into a short circuit and these short circuits in turn cause severe mechanical stresses to be set up in the windings of the transformers and the generating apparatus.

With a grounded neutral, therefore, it is reasonable to expect that the windings of the transformers and generators will be subjected to much more frequent shocks than without such a ground. Also owing to the fact that every ground immediately becomes a short circuit and that at points of short circuit the arc will cause considerable destruction, the system with the solidly grounded neutral will be subject to more frequent destructive arcs both on the line and in the apparatus where there is probability of such arcs developing.

It is my own opinion that so far as protection to apparatus is concerned, the advantages of grounding the neutral very much outweigh the disadvantages, and if protection to apparatus alone were to be considered, I would have no hesitation in making recommendation for a solidly grounded neutral.

Second—Protection to the service. As mentioned above, the disadvantage of a solidly grounded neutral is that every ground develops immediately into a short circuit. With a voltage such as is always used in high tension transmission, (say 44,000 and above) there will always be a sufficient voltage at the point of arc to cause that arc to continue until power to that particular section of line is cut off. This fact almost invariably will cause an interruption of power whenever a ground occurs on any point on the transmission system.

This would not be so materially a disadvantage were it not for the fact that experience has again and again demonstrated that lightning storms will very often cause insulators on the line to arc across or puncture. With the neutral solidly connected to ground each one of these punctures and flashovers means an interruption of service. If the line were not solidly grounded it is probable that many of these flashovers would not interrupt the service, since a flashover involving only one conductor might simply mean that the other two conductors on the transmission line would momentarily rise to a potential nearly double normal while the arc at the defective insulator, as well as the voltage to maintain the arc, disappears.

In view of the difficulties which the line is apt to encounter with a solidly grounded neutral many engineers prefer to ground through a resistance instead of connecting the neutral solidly to ground. In order to be of use the resistance between the neutral and ground must be relatively high and it further must be able to carry a considerable current for at least a short period of time. In other words it must be capable of dissipating a very considerable amount of energy for a short period. A satisfactory type of resistance for this grounding service is difficult to secure. Cement columns have been used but these are unsatisfactory owing to the extreme variability of their resistance. Also if the current through them is maintained for an appreciable time the heat developed is apt to crack or even to burst them. After studying the question from various angles, I have come to the

opinion that a metallic form of resistance is the proper one to use for this purpose. The main disadvantage of this form is its cost but its advantages are sufficiently great to overcome this disadvantage.

To recapitulate briefly the protection against surges of electrical equipment including both the apparatus and transmission lines may be furthered by adopting some or all of the following methods.

First—The overhead guard wire. This has the ability of keeping down the quantity of electricity which a given lightning discharge is capable of superposing upon a transmission line. In practice it has shown itself to be a valuable device in many instances of high tension transmission.

Second—The use of efficient lightning arresters is essential. They should be of a type which will allow a free discharge of static electricity from the transmission line whenever the voltage of the charge exceeds normal by a certain predeterminable amount. With a proper equipment of such lightning arrester the size of the surge which may enter electrical apparatus is limited.

Third—The grounded neutral. Grounding solidly prevents the potential of a neutral point of a transmission line from departing from ground potential. This in turn will prevent the normal operation of this line from causing more than about 58 per cent of line voltage appearing between any conductor and ground. Grounding through a resistance has the same effect to an extent depending upon the amount of resistance used.

Fourth—Insulation between turns. The analysis in the preceding discussion shows that it is highly essential to insulate electrical apparatus between turns so that it will stand a momentary potential which is many times that normally put upon that insulation. The consideration of this point shows at once the enormous advantage of using transformers upon a transmission line in distinction to connecting generators direct. The amount of insulation that can be used between turns in a generator is limited by the necessity of placing the winding in relatively small slots. In a transformer this consideration does not operate to nearly so great a degree owing to the fact that the space occupied by the windings is, so to speak, in one piece instead of being divided up into a large multiplicity of small slots. Also the presence of oil in the case of the transformer gives it an advantage which the generator cannot have under any conditions.

A NEW WIRELESS DETECTOR.

A new detector for Hertzian waves has been found in a crystal of iron pyrite upon which rests a conducting point. As described in a recent number of Comptes Rendus of Paris, this device works without a cell and is not impaired by heavy discharges or atmospheric disturbances, and with micrometer adjustment gives displacement in two directions at right angles, so that contact may be made at the points of maximum sensibility. The conducting point is mounted at one end of a lever, which has a movable counterpoise to regulate the contact.

ILLUMINATING ENGINEERING FROM A CENTRAL STATION STANDPOINT.[1]

BY W. M. HAMILTON.

Illuminating engineering from a central station standpoint is very largely a commercial proposition. To begin with, the central station man who is engaged in illuminating engineering work for his company, must always remember that he is not in the position of a regular consulting engineer, employed by the party for whom he is laying out the installation, and that the compensation for his services is not to be a certain percentage of the cost of the installation or some fixed amount, but that the compensation is to be derived through the medium of the sale of current, and is exactly proportional to the amount of increased revenue obtained in this manner, due to his work.

This means that in order to make his work "worth while," he must either increase the customers k. w. hour consumption per month, by installing an installation of a greater k. w. demand, or leave the k. w. hour consumption the same, and plan the new installation so that the customer will be so well pleased with the better illumination obtained, that he will serve as good advertisement and induce other people to use more current, or to become one of the company's customers, if not already one.

There is one other case, in which his work will be of full value to his company, in which he may not fulfill either of the above conditions, and that is in the case of a customer who is complaining of excessive bills. In this case, he must keep the k. w. hour consumption the same or very nearly so, and make the illumination so much better, that the customer will not consider the bills excessive in the future, even though they are as large as they were before the installation was remodelled.

By so doing, he will have changed a dissatisfied customer into a satisfied one, which is well "worth while" any time. Even if the company does not get any favorable advertising through that particular customer, after the change is made, you will at least have stopped him from "knocking" you.

In the case of a new installation where the prospective customer has sought the advice of the central station with regard to the proper units to use and arrangement of same, the "illumination expert," as he is often introduced to said customer, must first become a "psychological expert" and study the customer and estimate the size of his bank account in order to determine how much he will cheerfully spend each month for the artificial illumination of his premises. The factor of a personality is very strong in this last question, for there is a wide variation among merchants and others, engaged in the same line of business, and having practically the same amount and class of trade, in the amount of money that they are willing to pay each month for "lighting." One of two merchants having stores almost exactly alike, will consider it good policy and be willing to pay 50 to 80 per cent more than the other merchant, therefore the man who is to lay out the installation must determine his client's ideas along these lines. Having formed

[1] Paper read at convention N. W. Electric Light and Power Association, Seattle, September 7, 8, 9, 1909.

an idea of this, he must then determine if the customer has any whims or hobbies in the lighting line.

Inasmuch as some customers have some idea of what they want but cannot give intelligent expression to their ideas, it becomes necessary for the so-called "expert" to do some more "nature study work" and "mind reading" before he is ready to take up the actual engineering work of planning the installation.

If, in remodelling an installation, the engineer increases the k. w. demand, and therefore the k. w. hour consumption per month, he must improve the illumination so that the customer will be so well pleased, that he will not object to paying the increased cost of operation. Of course it goes without saying, that a person engaged in this work must be perfectly honest with the customer, and if the installation which he lays out will take more current per month, than the old one, he must not lead the customer to think that it will not do so, and in most cases, it is advisable to tell the customer that it will take more beforehand, for the customer is less apt to object then, or later when the bills come in, if he has been so advised beforehand.

I do not wish to give the impression by the above remarks that I consider it advisable for a central station engineer to lay out the heaviest installation that he can, and take a chance on the customer not complaining of excessive bills. His main effort by all means should be to lay out an installation that will be perfectly satisfactory to the customer, in every respect; for the prime object of his company in offering his services to its customers, is to aid them to obtain satisfactory service, and he should continually bear that in mind.

The central station engineer must always remember that he is always where the customer can "get at him," and that his company has a running account with said customer, that requires settlement each month, and if the customer is dissatisfied with an installation that the engineer has laid out, it is not only a reflection on the engineer's ability, but it also becomes his duty to take up the customer's complaint, and satisfy him in some way. He is therefore made to pay a double penalty for his failure to "make good" in the first instance.

It will thus be seen that the man doing this kind of work for a central station has difficulties and conditions to contend with that the regular consulting engineer does not. For the consulting engineer does not have to try to increase or maintain the k. w. hour consumption per month, and if his work does not prove satisfactory to the customer, the only penalty that he pays, is the reflection on his reputation as an engineer. For by the time the customer decides that the installation is not satisfactory, it is often several months after the installation is completed, and the consulting engineer would be on another job by that time and have no further relations with the dissatisfied customer, which is not true of the central station man.

Now to discuss some of the principles of artificial lighting.

It must be remembered that artificial lighting is divided into four principal divisions, to wit:

Illuminating lighting (or illumination).
Spectacular lighting (such as signs, etc.).
Decorative lighting (for beautifying objects).
Beacon lighting (lighthouses, etc.).

The great bulk of lighting consists of the first. Artificial illumination, according to my use of the word, means the process of making certain objects visible to the eye, by projecting artificial light upon such objects. It must be remembered that the prime reason for producing artificial illumination is to make it possible for the eye to distinguish surrounding objects and to examine closely those objects of most interest, and therefore the best form of illumination is that, which makes the outlines of such objects most readily discernable to the eye.

It is the common opinion, among those who have not given the subject much thought, that the higher the intensity of illumination is, the better the eye can distinguish objects and characters. This opinion is demonstrated by the fact that very often a person will be reading or writing under an electric or gas lamp, and their eyes will begin to pain them. They will stand it for awhile, and then glare at the lamp and condemn it as not giving sufficient illumination. Then they have a lamp of a greater candle power installed and feel satisfied for a time, until their eyes begin to hurt them again, and then they get a still larger lamp, and so on. Finally they conclude there is something wrong with their eyes and go to an optician, and he examines their eyes, and sells them a pair of glasses. That's his business. Ninety-nine times in a hundred the real cause of the trouble was the fact that the light from the lamp shone on the paper in the wrong direction, causing the eye to receive the "regular reflection" of the rays of light from the lamp, or "glare" as it is sometimes called. I have been astonished at the lack of knowledge, on the part of men and women who were otherwise intelligent, of the cause, of the glare that they notice on the paper, that they are reading. I have repeatedly called their attention to the glare, and asked them if they knew what caused it, and they have admitted they did not, after having made a guess or two.

The common form of desk lamp is more often the cause of this trouble than any other. The lamp is most often placed in the center of the desk right in front of the writer or reader, and at about a level of the person's eyes. This is the worse possible position for it to be in, for there is bound to be some point on the paper at which a ray of light from the lamp and the plane of the paper will form an angle of the same magnitude as that of the angle formed by the line of vision from the eye to the point, and the plane of the paper. Therefore, if the paper is glazed, the eye will receive the regular reflection of light from the lamp, and as such reflection is bright, it will be injurious to the eye.

This condition can be bettered by moving the lamp to the left hand end of the desk. The trouble then is, that you will still get the glare at times and it is almost impossible to focus the light on your paper, without exposing the lamp itself to the eye, which is even worse than the glare from the paper.

I have made several experiments to determine the best location for a lamp, when used for lighting a desk or table, at which a person is writing or reading, and have decided that it should be placed 36 inches above a point on the front edge of the desk, which point is 16 inches to the left of the center of the desk. If a 16 candlepower lamp is used and equipped with a concentrating reflector, the intensity of illumination will be ample for a person of average eyesight.

This rule holds good, where the person is sitting facing the desk and opposite the center of same. As a person generally turns a little to the left when writing, it is advisable to have the lamp placed at the left, instead of at the right, because of the shadow that is thrown by the hand on the paper on the spot where the person's pen is in contact with same, when the lamp is at the right of the writer.

If the left hand end of one's desk is against a wall it is an easy matter to place the lamp in the position mentioned, by means of an adjustable bracket fixture, or a standard portable fixture which may be hung from one screw in the wall, and set on the desk during the day, if desired. If the left end of the desk is not against the wall, the desired location of the lamp may be obtained by making a few simple changes in a Standard Faries No. 1012 portable desk fixture. These changes consist in lengthening the arm and attaching a brace to same.

There is a more important point than that of glare, or regular reflection, that I should have taken up before, and it is that of exposed light sources in the field of vision. Everyone knows that this is a serious question, and that it is very poor practice to subject the eye to the direct rays of light from an illuminant. Attention has been called to this point time and time again, but as "repetition sometimes lends emphasis" I am going to repeat, in hopes that this will be one of the times when it will do so.

As I said before, many people are of the opinion that their ability to see clearly, is directly proportional to the intensity of illumination on the object at which they are looking. Of course this is far from being the case in many instances, as can be easily illustrated in one way, by holding a paper or a book, say two feet in front of a person and then placing a bare lighted 16 candlepower lamp one foot in front of the paper, so that the lamp will be about midway between the observers' eye and the paper, but not in the direct line of vision between the eye and the paper. The intensity of illumination on the paper will then be approximately 16 foot candles if the lamp is held properly. Now move the lamp to a distance of four feet back from the paper so that it will be out of the observer's range of vision. The intensity now is only one foot candle, but the observer will tell you he can read what is on the paper with less eye strain, when the lamp is in the latter position than he can when it is in the former. The illumination in the latter case is only 1-16 as intense as in the former, yet he can see better.

This is due to the fact of course, that the diameter of the pupil of the eye is reduced by the intense light from the lamp when same is held in front of the observer, and the amount of reflected light from the paper, that enters the eye and is thrown upon the retina, is reduced.

The iris of the eye acts the same as a shutter of a camera and allows more or less light to enter the eye according to the amount required to give the best results. It also acts as a protector for the retina to a certain extent, and always adjusts itself to accommodate the greatest intensity of light entering the eyeball. Therefore in the above test, where the light from the lamp was shining in the observer's eye, the iris was adjusted, for the high intensity of the direct rays of light from the lamp, and not for the reflected light from the paper, whereas when the lamp was behind his head, the brightest object in his range of vision was the paper, and the iris was adjusted for the intensity of light that was reflected from the paper. Thus the retina received a sharp and distinct image of the characters on the paper, as the latter was the brightest object in the range of vision, and the maximum number of rays of reflected light from same were permitted to enter the eye.

I do not wish to convey the impression by what I have said above, that I consider that the average intensity of artificial illumination is too high at present, for it is far too low as a matter of fact, but that more attention should be given to the direction of the projected rays of light, and to the location of the light sources with relation to the field of vision. It is better to have lower intensity with the light source out of the range of vision, than to have a greater intensity with the lamp in the range of vision, but it is still better if the greater intensity can be maintained, and also have the lamp out of the field of vision.

Inasmuch as the eye has grown accustomed to daylight illumination through generations and generations of natural light, we should, when producing artificial illumination, endeavor to reproduce the effects of daylight. This means we should try to reproduce the color, the intensity, the direction, and diffusion of light that is obtained from the light of the sun. The reproduction of the color is a matter that is mostly in the hands of the lamp manufacturers, and we are glad to note what rapid strides they are making in their part of giving us lamps that will produce light of nearly the same color values as that of daylight.

The intensity can be reproduced provided the cost of operation is not limited. The reproduction of the direction and diffusion is generally a very difficult matter, for interior daylight illumination is generally produced by the light that comes through the windows, which are usually on one side of the room, which gives the light a definite direction, and although the light may come through one window, it comes from such a large area outside, that the diffusion of light in the room is very uniform. Owing to the intrinsic brilliancy of the common artificial light sources, it is not practical to place them on the same walls of the room, that the windows are located, in order to obtain the same direction of light, unless the light from the lamps is diffused to a very great extent by means of diffusing glass.

It would be possible, but not practicable to effect a very close reproduction of the direction and diffusion

of daylight in a room, by building a portable cabinet, that would just fit into the window opening. This cabinet to consist of a glass front and sheet metal back and sides. The glass to be of a nature that would thoroughly diffuse the rays of light that were projected through it. In this cabinet, place as many horizontal rows of small tungsten lamps as possible, the lamps to be as close together as practical. The glass front would be faced toward the inside of the room of course, and the metal back would be polished to act as a reflector. The cabinet could be mounted on hinges, and swung either to one side or up against the ceiling during the day. If there was enough wall space between the windows, this cabinet could be built therein, and thus remove the objection to the former scheme of ungainliness of the cabinet. There still remains the high cost of operation, however, which makes the scheme impractical for almost any consumer.

The effort to reproduce a diffusion of artificial light equal to daylight has been made many times, but the diffusing surface has either been the ceiling it self or a glass false ceiling. It has been found by actual practice, that the large majority of people find that their eyes become very much strained and injured in time, when using them for the common purposes of reading, writing, sewing, watching a public speaker, etc., in a room illuminated by reflected light from the ceiling or by diffused light through a glass false ceiling.

This eye strain and fatigue is due mostly to the two following facts: One is that for generations and generations the human eye has been accustomed to receiving light from low angles or altitudes, when one is engaged in such work as reading, writing, sewing, using small tools, watching a person who is making an address, etc., as all of these pursuits are generally carried on indoors, where the light comes through windows. Therefore that portion of the retina of the eye upon which light strikes, when entering the eye from low angles, has become accustomed, and is adapted, to receiving greater intensities, than are other portions of the retina. Therefore, when the rays of greatest intensity, that are entering the eye, enter at some unusual angle, they strike upon some portion of the retina that is not accustomed to such high intensities, and cause eye strain.

This not only holds good for cases where the light enters the eye from very high angles, but also from very low angles. A proof of the latter is snow-blindness, which is caused by the intense light entering the eye from an unusually low angle.

When walking on very light colored cement walks on a bright, sunny day, I find the reflected light from the walk very trying on my eyes and find relief by looking down at the pavement right in front of my feet, thus allowing the reflected light to enter the eye at that angle, at which, it is most accustomed to receiving high intensities. The average person would think that the relief was due to the fact that my eyes were better shaded from the light from the sky, but as a matter of fact there is very little light thrown by a clear blue sky, and it is generally on such days, as the sky is clear that the sidewalks are the brightest. On the other hand, anyone who has tried to do any amount of work under a skylight, or out doors, under a slightly overcast sky, without the use of eye shades, knows how tired his eyes became, although he may not have realized at the time, what was the cause of the eye strain.

The other reason why illumination produced by a bright ceiling is hard on the eyes, is that there is a lack of shadows which in turn means a lack of "perspective." It is by the means of shadows, or the light and dark surfaces of an object of uniform color, that we determine the character of the surface of an object. Of course a person can distinguish the outline of an object, if it is placed against the proper background, but you cannot judge of its surface unless there are some shadows, for the surface will appear flat, even though it might be quite rough, and if there are no shadows the eye immediately begins to "hunt" for some, that will help it to determine if there are any projections on the surface, and it becomes tired from its futile effort to do so.

As long as a person is looking at a flat surface such as a sheet of paper, this effect is not noticed, but as soon as the eye leaves the paper to focus on some other part of the room or desk, the strain begins, and for that reason, I do not consider any method of illumination advisable, that will not produce definite shadows, even in offices where the principal occupation of the eyes, of the occupants, is that of reading or writing. The only exception to the above that I can think of at present is in the case of a draughting room, where the absence of shadows is very desirable, as far as the actual draughting requirements are concerned.

Referring to my previous statement to wit: That the human eye has become accustomed to receiving the greatest intensities of light from low angles, due to the fact that most of the light comes through windows. Some one may think that does not hold good, when one is outdoors. That is true, to the extent that the light comes from above, instead of from the sides, but it does not generally enter the eye from the higher angles, for the reason that the hat brim shades the eye, in such a way, that the light can only enter in a more nearly horizontal direction.

In the absence of a hat brim, on a bright day, one generally shades the eyes with the hand, or inclines the head forward, so that the eyebrows will protect the eyes from the bright sky, and on those days that we have a clear blue sky the greatest intensities of light that ordinarily enter the eye, do not come from the sky, but from surrounding objects.

Furthermore, when one is outdoors, their eyes are generally not engaged in making close and detailed examinations of small objects, but are looking first at one large object and then another and therefore less concentration is required. Owing to this very fact, that it requires less effort for the eye to distinguish large objects, the coarse details, and is focussed first upon one object and then another, it is not necessary for the iris to admit a very large amount of the reflected light into the eyeball, and the pupil is comparatively

small, which prevents, to a large extent, any extraneous light from striking upon the retina. The difference in the effect produced by high intensities of light entering the eye when same is focussed on any one point for a length of time, and that produced under the same conditions, when it is focussed first on one point and then another, may be observed in an auditorium where a speaker is addressing an audience. The auditorium being illuminated by means of exposed light sources.

It will be found upon investigation that the speaker does not experience nearly as much eye fatigue, due to the exposed light sources, as does any one in the audience, who has been watching the speaker closely.

This is due to the fact that the speaker's eyes have been focussed first on one place and then on another, whereas the person in the audience has had his eyes focussed upon the speaker all the time. Most anyone of an audience, in similar circumstances, will either voluntarily, or involuntarily, look away from the speaker to some other part of the house when their eyes commence to "burn," and thus obtain relief. The reason why the shifting of the point of focus gives relief this way, is because of the fact, that when the eye is focussed in one position for any length of time, and there are some light rays of high intensity entering the eye, the rays strike upon some one portion of the retina, and this continued concentration acts similarly to the rays from a "burning glass" (as a magnifying glass is sometimes called) and tends to "burn" or "break down" that portion of the retina upon which the light is falling, whereas if the point of focus is continually changing, the point on the retina upon which the rays of high intensity are striking, is also changing, giving each point a chance to "build up" or recuperate, after the light has shifted to some other point before it is "broken down" or "burnt" to an injurious extent.

I have thus discussed as a few of the effects of light upon the eye, for the reasons that they must be taken into consideration in almost all illuminating engineering problems, and a person engaged in that line of work must have a good understanding of the effect of light upon the eye before he can successfully solve the various problems.

Of course he must also be well informed on the most modern illuminants, modern wiring methods and requirements and have a general knowledge of the principals of architecture and art insofar as they have a bearing on the design of the lighting installation. These requirements are generally known and acknowledged as being necessary, but I do not believe that enough consideration and attention is given to the bearing that the eye and eyesight has on the subject and therefore I have called particular attention to same.

Now to take up the study of a few classes of illuminating engineering problems.

The one class of installation that offers the most difficulty to the central station man engaged in illuminating engineering, is that of installations for large office rooms where there are a large number of people engaged in office work in one room. I do not mean that this class of installation is the most difficult one to design (for there are but two schemes that are practical), but that such installations present the greatest number of difficulties owing to the fact that we have so many of them to handle, and they are very seldom satisfactory from all standpoints when completed. I have found only two schemes, that are practical, for this class of premises. One, is that of having a number of units placed against the ceiling, of such capacity as to provide a mild general illumination, and then having an individual desk lamp for each person.

This makes the best installation, from a standpoint of illumination, but there are serious objections to it, owing to the cost of installation, limited arrangement of the desks due to the location of the floor plugs, the danger of fire from portable cords, and lastly but principally, owing to the fact, that the numerous desk lamps are very unsightly in a modern office.

This last objection is more pronounced in the office, where low flat top desks are used, instead of the old high standing desks, and where the neat general appearance of the office is a matter of much more importance.

The other scheme is to provide an overhead installation, of such capacity, as to provide a sufficient intensity of illumination at desk top level for reading and writing. By placing the lamps in uniform arrangement, the neat appearance of the office is maintained, and the high intensity of illumination gives the appearance of a wideawake successful firm. All this will please the proprietor, but will not be appreciated by the clerks, for they are more concerned with the illumination of their books and papers. As a rule, the majority of clerks much prefer the first method, because, they can have their desk lamps "just where they want it." Although the latter scheme may be really the best for them owing to the very likely misuse of the desk lamp, they do not think so, and inasmuch as the engineer's main desire is to provide an installation that will be satisfactory to all, he will very often fail to do so, if he does not provide the clerks with desk lamps. Therefore no matter which scheme you adopt, you will very seldom succeed in satisfying both proprietor and clerks.

The real and sound objections to the wholly overhead scheme, are, that in many instances, the clerks will not be able to avoid the direct reflection or glare, from all lamps, and in other instances, their bodies, heads or hands will cast a heavy shadow on that part of the paper at which they are looking. Then, too, in most instances some of the lamps are bound to be in the range of vision and the direct rays of high intensity shining in upon the retina very soon causes pain.

The two former objections can in many cases be removed, provided the clerks know the cause of the glare, and how to avoid it, and will take the trouble to do so, and if the person in charge of the office will permit of an arrangement of desks that will cause the least number of disagreeable shadows and reflections. The latter objection (that of lamps in the range of vision) can be practically removed by the use of

eye shades, but there is a strong objection to the use of eye shades by the majority of clerks and office men and women.

The men generally object to their use because they think, that if they use them, that their eyes will become weakened, and that they will always have to use shades. Of course, that is not so, as anyone knows who has investigated the matter. Protecting the eyes from injurious strains, has the same effect upon them, as that of protecting any other muscle or organ of the body from injurious strains, has upon such muscles or organs.

Other men do not like to be bothered with the shades, and had rather let their eyes suffer than to take the trouble of putting the shades on and off. Some few of the men and most of the women object to them because they think that the shades mar their beauty, even if they have none to mar. It is very hard to find an argument that will eliminate the last objection, and when I meet it I generally feel that the person offering it ought to suffer, and I make but little effort to convince the party that their eyesight is worth a whole lot more to them than real or imagined beauty.

Some illuminating engineers claim that the objections to an entirely overhead system of illumination for a large office, can be eliminated largely, if not wholly, by the use of proper diffusing glassware. My own experience disproves this theory, for we have tried out an installation in our accounting department in which the most approved form of diffusing hemispheres was used, and whereas there was plenty of intensity, still the results were not entirely satisfactory, because of the glare and shadows.

The X-ray inverted reflector system or the General Electric Company's concentric diffuser system, form the best two that I know, for a wholly overhead lighting system for this class of work, but are not entirely satisfactory.

If a combination system is used, embodying overhead lamps and desk lamps, care should be taken to see that the variation in the intensity of illumination between that of the general and special illumination is not too great. There has been considerable discussion on this point before the Illuminating Engineering Society, and other organizations, some of the members contending that it is best to have the general illumination very low, so that when a person looks away from the brightly illuminated book or paper, into the comparatively dark room the eyes will be rested. The contention being that when one wants to give the eyes complete rest the natural thing to do is to shut all light out of them, by closing the lids. They further contend that this is demonstrated by the sense of rest that is actually experienced when one looks away from a brightly lighted paper into a darkened room.

The argument that is advanced against this contention is that, whereas it undoubtedly rests the eye to look from a brightly lighted object into a darkened room, the shock and strain on the eye, when you look back at the bright object does more harm to the eye, than the good done, by the act of looking from the bright object to the dark one. Furthermore, it is contended that the sudden and violent expansions and contractions that the iris of the eye undergoes, when one looks from one place to the other, is as harmful as any other sudden and violent muscular action, and if these changes take place frequently, the damage done is proportionately greater.

One more argument why there should not be a wide variation between the general and special illumination, and one that I have not heard or seen advanced is that the eye has become accustomed to daylight illumination, and therefore we should try to reproduce the same effects with artificial illumination that obtain with daylight. A moment's reflection, will tell you that the variation should be of a minimum value.

School rooms are not so hard to illuminate as large offices, for the reason that the occupants all face one way with the exception of the teacher, and the light sources can easily be concealed from the view of all but the teacher by using the proper kind of a shade or reflector, and the light made to come from a more desirable direction so as to eliminate a large amount of the glare. Such a shade or reflector would be one that would allow the light to be thrown forward and down but not backward.

The illumination of small offices is a simple matter, for special illumination can be provided very easily, and the objections to the appearance of the desk lamps is not so great as they can generally be set out of sight when not in use.

Store illumination is comparatively simple, also, as it is only a question of color values, the proper amount of intensity and the size and location of the units. The first one or color values is the only one that offers any serious difficulties, for that form of an illuminant that gives the best color values for displaying certain classes of goods may not give the best values for other classes of goods, that may be displayed under the same illuminant.

For instance, evening dresses and dress goods require those color values that prevail in the ballroom, theater and reception room, for that is where such goods are used. On the other hand, millinery, street dresses and dress goods should be displayed under that form of illuminant that produces the nearest resemblance to daylight, for such goods are used in daylight. Therefore, the only way by which satisfactory color values may be obtained for all classes of goods, is to have them separated according to the color value required and have separate rooms for displaying goods requiring different values. The only way to do where this scheme is not feasible is to install that form of illuminant giving the nearest approach to daylight as the large majority of goods require those values.

The proper intensity of illumination is a factor that is governed so largely by the amount of money that the customer is willing to pay each month for current, that it is very difficult to stipulate just what is proper in the sense of the proper amount that will be satisfactory from a standpoint of cost of operation as well as illumination, and the only answer I know of, is, that the proper intensity is the nearest that of good daylight near a north window, that the customer is willing to pay for.

I give below some figures showing the amounts of current per sq. ft. of floor area that some of our Portland merchants and others are paying willingly (or at least without serious protest)

Schedule of current allowances in various installations in Portland, expressed in watts per sq. ft. of floor area illuminated:

	Watts per. sq. ft.
Churches—	
Scottish Rite Cathedral	1.35
Vernon Presbyterian	1.00
Clubs—	
Arlington—Card Room	2.6
" —Billiard Room	3.04
" —Dining Room	1.02
" —Library	1.65
Commercial—Dining Room	1.7
Concordia—Ball Room	2.9
" —Banquet Hall	2.4
" —Card Room	2.7
" —Gymnasium	1.5
Multnomah—Reading Room	1.25
" —Reception Hall	1.22
Offices—	
Kerr, Gifford & Co	1.9
N. P. Ticket Office	2.08
O. R. & N. Claim Office	2.04
Wells Fargo Bldg	2.48
Restaurants—	
Brunswick	2.68
Day's	1.62
Hall's	1.82
Oregon Grill	1.4
Portland Hotel	2.3
Saloons—	
Batchelor	3.0
Doyle	2.5
Schiller	1.26
Stores—	
Needlecraft	1.73
Constantine Butcher Shop	2.
Bonboniere Candy Store	2.
Coffman Candy Store	4.
Hewitt & Bradley—Clothiers	2.00
Bartholomew—Clothiers	2.8
Meier & Frank—Clothiers	1.9
	1.6
Rosenblatt—Clothiers	2.2
Ben Selling—Clothier	1.32
A. B. Steinbach—Clothier	1.54
Skidmore Drug Co	2.83
Tull & Gibbs—Furniture	1.3
Aronson—Jeweler	4.2
Feldenheimer—Jeweler	3.6
Leffert Bros—Jewelers	2.5
Le Palais Royale Millinery	1.2
Florsheim—Shoe Store	1.4
Knight—Shoe Store	1.5
Rosenthal's—Shoe Store	2.15
Staiger—Shoe Store	2.15
H. B. Litt—Tailors	1.65

The size and location of the units is one that is governed largely by the size of the store, and the height and construction of the ceiling. If the ceiling is divided into panels, the question is very quickly solved, for it is generally self evident how many units should be hung in any one panel and therefore all that remains to be done, is to divide the amount of current that has been allowed for lighting the room, by the number of panels, and the result by the number of units per panel. This gives you the size of the unit in watts and a selection of the nearest standard unit can be made.

In large stores, large units are more suitable and desirable and small ones in small stores, although nothing larger than an enclosed arc should be used for purely illuminating purposes, in any store.

The height of the units is dependent upon the height of the ceiling, and the amount of current that has been allowed for lighting the premises. They should always be hung as high as the amount of current allowed will permit. This, I have found, in Portland, to be 10 and 12 feet from the floor. Of course, if the store is a very small one, and economy must be given prominent consideration, then the units should be hung a little lower, to get sufficient intensity of illumination with the amount of current available. Furthermore, it is undesirable to hang the lamps low in a large store, because there will be more of them in the range of vision, and the lamps will become more conspicuous than the goods on display, which is, of course, undesirable.

What I have already said relates to the illumination of such stores as clothing, dry goods, jewelry, grocery, and butcher shops, where the principal purpose of the lighting installation, is to illuminate the goods for sale.

Candy stores, ice cream parlors, saloons, restaurants, etc., require entirely different treatment, for in such places the illumination of the premises is only of partial consideration and the spectacular effect very often is of most importance.

Now as to the illumination of the windows of the first mentioned class of stores. The illuminants should be concealed from view of course, for if they are not, they will make more of an impression on the eye and mind of the casual observer, than will the goods on display, and he will go away with a recollection of having seen a bright light in that particular window, whereas if the light sources are concealed, the goods on display will be the most prominent objects in the window, and the recollections that the observer will carry away with him, will be that of having seen an attractive suit of clothes or a pretty dress, etc., in that window, which is what the proprietor of the store wants.

The light sources should be placed as close to the glass as possible, and as high as possible, so as to put them out of the range of vision, and to throw the light on that side of the goods at which the observer is looking, and the reflectors should be so focussed as to make the intensity of illumination a little higher near the front of the window than at the back, for a person looking at goods in a window, very seldom tries to examine the texture of the goods in the rear of the window, whereas they do want to do so with the goods in the front of the window.

The bottom and back of the window should be finished in light colors and the ceiling should be pure white, if possible. The light bottom and back will serve as a good background for the goods on display, and will give the window a bright, attractive, general appearance, that cannot be obtained in a window that is finished

in dark colors, no matter how much candlepower is used. There should also be an opaque or transparent sign painted on the window in front of the lamps, so as to hide them from view, when one is across the street or on the edge of the sidewalk. If the above conditions are fulfilled, 60 watt tungsten lamps placed 18 inches apart in a row along the front of the window will give an attractive result.

The lighting of candy store windows, etc., is an entirely different problem, for here the light sources may very often be exposed with very excellent results, and spectacular effects are generally sought for.

The successful illumination of churches is a very difficult problem, and one that requires considerable study in each case. The light sources should be kept out of the range of vision of course, and this may be accomplished either by concealing them behind pillars, beams, etc., or by enclosing them in reflectors or shades, that will allow the light to be thrown forward and downward but not backward.

Shop and factory illumination is one that is subject to a wide variety of treatment, owing to the wide variations in the requirements, but as a rule, a general illumination from overhead units, in conjunction with special or local illumination at the various machines and benches is required to give satisfaction.

Flaming arcs are very successful in foundries and large machine shops, as the yellow rays have the greatest power of penetration in air that is smoky or hazy. Owing to their high efficiency they may be hung above cranes and still give sufficient illumination on the floor.

The illumination of residences is another one of the classes of installations, for which no hard and fast rules can be made, and furthermore the finances of the owner and tenant have a very important bearing on the problem. The average residence should have the following if possible: In the living room, a center unit or fixture with the lamps near the ceiling or not less than 8 ft. from the floor, a floor plug under the reading table for the connection of a table lamp or fan, a base board plug behind the piano for the connection of a portable lamp on the piano, and a bracket lamp or two over the ends of the window seat if there is one, or near a window in case there is none. There should not be any beside the fireplace for one generally sits facing the fireplace, and the lamps would thus not only be useless, but harmful, if placed in that position.

The same arrangement holds good in the dining room with the exception of the bracket lamps which are not needed. The base board plug should be behind the sideboard, and will be used for the connection of a fan, etc., and the floor plug under the table will be used for the connection of a chafing dish, toaster, miniature decorative lighting outfits, etc. A dome is very often desired over the table, but if same is used, a few lights should be placed close to the ceiling, above the dome, so as to provide a general illumination of the room.

In the bedrooms there should be a bracket at each side of the dresser, one over the wash basin, one over the head of the bed, and one over the lady's dressing table, or if the exact location of the furniture cannot be predetermined, baseboard plugs should be provided as near as possible, behind where each of the above articles are apt to be placed. Then portables may be fastened to the furniture later on and connected to the plugs. A center lamp should be provided of course, and controlled by a wall switch near the door.

Street illumination is a topic by itself and I will not undertake to discuss it in this paper.

In conclusion I wish to call attention to the unanimous opinion of central station managers, who have had men engaged in illuminating engineering work, of the great value and benefits that have been derived from the work that the men have done along these lines. They have found that the customers appreciate our services, and that good feeling is thus created, that could not otherwise have been acquired, and we therefore feel that it is a wise policy for every central station to have at least one man who devotes at least a part of his time to illuminating engineering work in behalf of the interests of his company and its customers.

ELECTRICITY AND MATTER.

The latest theory advanced by Professor J. J. Thomson in his presidential address before the British Association for the Advancement of Sciences, "is that matter is just a collection of positive and negative units of electricity, and that the forces which hold atoms and molecules together, the properties which differentiate one kind of matter from another, all have their origin in the electrical forces exerted by positive and negative units of electricity, grouped together in different ways in the atoms of the different elements.

"As it would seem that the units of positive and negative electricity are of very different sizes, we must regard matter as a mixture containing systems of very different types, one type corresponding to the small corpuscle, the other to the large positive unit.

"Since the energy associated with a given charge is greater the smaller the body on which the charge is concentrated, the energy stored up in the negative corpuscles will be far greater than that stored up by the positive. The amount of energy which is stored up in ordinary matter in the form of the electrostatic potential energy of its corpuscles is, I think, not generally realized. All substances give out corpuscles, so that we may assume that each atom of a substance contains at least one corpuscle. From the size and the charge on the corpuscle, both of which are known, we find that each corpuscle has 8×10^{-7} ergs of energy; this is on the supposition that the usual expressions for the energy of a charged body hold when, as in the case of a corpuscle, the charge is reduced to one unit. Now in one gramme of hydrogen there are about 6×10^{23} atoms, so if there is only one corpuscle in each atom the energy due to the corpuscles in a gramme of hydrogen would be 48×10^{16} ergs, or 11×10^{9} calories. This is more than seven times the heat developed by one gramme of radium, or than that developed by the burning of five tons of coal. Thus we see that even ordinary matter contains enormous stores of energy; this energy is fortunately kept fast bound by the corpuscles; if at any time an appreciable fraction were to get free the earth would explode and become a gaseous nebula.

THE TREND IN ELECTRICAL DEVELOPMENT.[1]

BY CHAS. F. SCOTT.

In reviewing the possible subjects which might be presented with interest to a general meeting of electrical men, one is impressed by the wide range of topics which might be selected and also by the specialized character of most of them. Many subjects which were foremost a few years ago have taken a secondary place as they have passed from the field of general engineering discussion into that of practical operation. The design and characteristics of generators and of ordinary switchboard apparatus, the construction and connection of transformers, the construction employed and the ordinary phenomena occurring in long distance transmission have lost their novelty and have become the subjects for discussion at experience meetings among those who are especially interested in them.

This does not mean stagnation; in every branch the manufacturer and the operator are alert; improvements in apparatus and methods are continuous; but the lines of development are fairly definite, advancement is accepted as the normal condition, and matters relating to fundamental apparatus and plant operation have taken their place in the category of established practice.

Interest now centers along certain other lines. We are now concerned with the use rather than the generation of electricity. The active problems today are those which pertain to the application of electric current.

To gain a general view of the situation we may, instead of enumerating specific uses, consider the possible field. Electricity supplies light, heat and power. Now nearly every activity in domestic life, in agriculture, mining, manufacture and transportation involves energy in one of these three forms. By old-time methods light was supplied by candles, oil or gas; heat was derived from fuel—wood or coal, oil or gas; power was produced by means of animals, by steam engines or water wheels. In nearly every case, the same result can be produced by electricity. Light, heat and power can be produced by a single agent instead of a dozen. That is the scientific possibility. Make a list of the things electricity cannot do, of the instances in which it cannot produce the needed light or heat or power, and see how short the list is, and note also how much better results are obtained, all the way from Christmas tree lights to searchlights, from the flatiron to the steel furnace, from desk fans to hoists and express trains. Electricity is not merely a convenient means of doing a few things; it is capable of universal service. Such, then, is the possible field from the scientific standpoint; the immediate problems are to determine what is practicable from the engineering standpoint and what is economical from the commercial standpoint.

In taking a perspective view of the present situation, one is impressed with the sudden and radical extensions which have taken place in the use of current in a very few years. In illumination, the simple 16 c. p. carbon lamp, and the enclosed arc lamp, have given place to new types, which in efficiency, length of life and quality of light have realized ideals which were beyond all reasonable expectations. The application of the electric motor to general domestic, commercial, industrial, mining and railway service marks an epoch in the history of power. Electric heating, which is still regarded as a novelty and a curiosity, is being applied to over one thousand different kinds of service.

What are some of the conditions which have produced this sudden and widespread activity, and which underlie future development?

The first condition is the fact that we are all power users. The fundamental thing which underlies the progress of the past century is the steam engine. The underlying factor in modern industry is the power-driven machine; consequently there is a ready field for the motor, which can apply power far more advantageously than the engine, and which can supply power for operations for which the engine is not applicable.

Second, is the evolution of the electrical system for supplying power. The work of designers, manufacturers and operators in developing the apparatus and methods for generating, transmitting and distributing electric power makes the electric current available, as it has never been before.

Third, there is a general industrial activity which is alert to adopt new and improved methods and a readiness to secure whatever contributes to comfort and convenience, all of which summarize themselves in a spirit of progress.

Granting these several conditions, namely, that there is an unlimited field for the use of electricity; that electric power is ready and available; and that there is a readiness to accept that which is good, the problem of electrical extension is to determine the best methods of application and to show that electricity can make good. Most people, particularly those to whom electricity is still a curiosity or a novelty, must be shown how to apply the electric current, and why it is worth while. The problem is not wholly engineering, nor is it purely commercial, but it combines the two. It is not wholly electrical, nor is it entirely mechanical and industrial, but the motor and the work which it is to do must be mutually adapted one to the other. The problem is not narrowly mechanical, it is not limited to securing certain specific results in some particular operation, but it involves methods and policies.

We are apt to take too narrow a view of the questions which are before us and to confine ourselves to mere details, without taking the wider vision to determine the larger things which are both possible and practicable.

In the use of electric current, whether for lighting, for power or for heating, there are several underlying methods or principles which appear when the conditions are analyzed.

1. The electric current is often directly applied to replace the former agent. Incandescent lamps can be placed on the same fixture and in the same position as gas jets. The electric motor can be belted to a line shaft. An electric heater can be placed inside of a cooking stove, in the usual position of the fire. In such cases the electric current generally proves itself advantageous and economical.

2. Electricity can usually do more and do it better. Old methods may have been devised, not because they were inherently advantageous, but because they

[1]Paper read before Joint Convention, N. W. Electric Light and Power Association and Seattle Section A. I. E. E., Seattle, September 7, 8, 9, 1909.

were necessary. Thus electric lamps can be hung down, whereas the old gas jets must stand up; electric motors can be made in small sizes and applied directly to the machines they are to drive, which is impracticable with the steam engine, and electric heating can be applied within the cooking vessel, which is impossible when fuel is used. These simple illustrations apply to the whole field of electrical application. It is usually an easy matter to make electricity do just what was done before, whereas better results can be obtained by the changes in methods which electricity makes possible.

In operating machine tools, for example, the electric motor not only supplies power which might be taken from an engine, but it can be directly applied to the tool and can run at a speed best suited to the work to be done, an advantage which often far outweighs any saving or convenience in merely supplying the power. It is this facility of controlling the speed of the motor in supplying electric power, and of controlling the temperature in electric heating which constitute the really great advantage. Considerations of this kind are of vital importance, all the way from the steel mill to the sewing machine.

3. Electricity can be used where there is no other means at hand. It is the only practical means of producing power in small units, such as is necessary for the operation of a desk fan, a sewing machine, or a hundred other common devices in the home, the office, the store, the hotel, or the shop. In these small units electricity replaces the most expensive source of power, the human muscle. The interurban and the underground electrical railway, the motor-driven pump for irrigation, the remote control of motors, are other instances in which electricity does what was not practical by other means.

4. The indirect and sometimes the unexpected advantages resulting from the use of electricity are sometimes of even greater importance than those which were directly sought. For example, an electrically driven machine may have in circuit a graphic recording wattmeter making a continuous record of the power used by the machine. Such a record shows the length of time the machine is idle. An analysis of the causes of loss of time may lead to some simple change in conditions which will result in increased output. Again, the length of time and the amount of power used in the successive operations, which are recorded, may indicate whether it is operating at its maximum rate. This is a check upon the manner of doing the work and upon the general surrounding conditions which has in several cases shown how to increase output and reduce operating cost sufficiently to more than pay for the cost of the electric power.

My attention has been called to the application of the wattmeter in a factory in connection with electric heating, such as by flatirons, in which the amount of power used is an indication of the amount of work done. The results show what is termed a fatigue factor; work starts briskly in the morning, but decreases till noon. Immediately after noon the rate is high, but it falls off much more rapidly in the afternoon and is lowest just before quitting time. Such a fatigue factor has an interesting bearing on the relative efficiency of the eight and the ten-hour day. It is also interesting to surmise how much more rapidly the fatigue factor would fall if gas were used and the air were hot and vile.

The important incidental advantages of the electric drive in the steel mill are shown in a paper read before the last convention of the American Institute of Electrical Engineers, by Mr. Friedlander. The paper purports to give a simple account of several years' operation of a direct current motor driving a pair of rolls, but there is scarcely a page which does not show wherein the motors are doing something which the engines could not do. Mr. Friedlander points out that the rolling mill drive has taught how to get the best relation among rotating masses, speed, time and horsepower. It has helped the roll designer to calibrate the rolls in such a manner that the power characteristics for all the passes are uniform, thereby avoiding high power peaks, decreasing the size of the prime-mover, and reducing first cost and fuel consumption. The watt-hour meter warns the roller of bearings or rolls becoming tight and hot, or that steel is causing excessive friction in the passes, thereby guarding against damage to the rolls and bearings. The meter indicates that lower heat, greater elongation and especially change of profile in different directions increase the power required at the rolls much more rapidly than do chemical hardness, high tensile strength or large draughts. After analyzing the conditions in reciprocating engines for this work, he finds that the characteristics of the electric motor are much better. A little further on he says heavy reciprocating engines can not run at such high speed and must be connected to the gears by means of gears, ropes or belts. Again, the motor gives accurate information as to the exact power requirements for rolling steel, whereas indicator diagrams taken on reciprocating engines doing similar work were misleading. Further on he says that with the use of electric motors in place of reciprocating engines the problem of reversing rolls becomes much simpler in regard to manipulation, fuel consumption and cost of maintenance.

Now all of these more or less indirect things are points of superiority which the electric drive has over the steam drive. They show a reaction or interaction between the motor and the mill which indicates how really important and vital is the electric system beyond the mere ability of the motor to drive a pinion, a pulley or a shaft.

A review of the general conditions shows, therefore, that the possible field for electrical service is unlimited, that apparatus is available for producing electric power, that there is a readiness to adopt superior methods, and also that electricity can generally be used as an economical substitute for other agents, that it can accomplish better resuits, that it can develop new fields and that it is accompanied by indirect or incidental advantages which are of great value.

These being the ground work on which we are to base our electrical development, there are a number of points which follow as corollaries relating to the general situation and to methods of applying electricity effectively, from both the engineering and commercial points of view.

(a) The electrical apparatus and the methods of application must be intelligently chosen. Increasing

discrimination is being exercised in applying electricity. The 16 candle power lamp and the belted motor of a few years ago did not receive much expert direction. But there are now illuminating engineers, with a society and a monthly paper, dealing with methods of effective illumination, and there are commercial engineers directing the application of motors, who study methods and gather data. A typical evolution is found in the machine shop. At first the motor was a convenient method of driving a line shaft. Next it was found more convenient and better to apply the motor directly to the tool, and then note what happened. The tool began to change, it could be run faster and varied in speed, it could be made stronger, it could operate new the high speed tool steels, and the designers of machine tools got together with the designers of electrical motors and they worked together to harmonize their machines in characteristics and mechanical form, and they made one unit of the two. As the result the electric drive is put in the machine shop, is not merely because it can furnish power a little cheaper but because the machine tool can be made to do so much more and can do it better and cheaper.

The need of specific adaptation has been recognized by the manufacturers of electrical apparatus. Instead of a few sizes of motors running at one or two definite speeds, they now offer a great variety of motors having different mechanical forms and speed characteristics specifically adapting them to the work which they are to do. A tremendous amount of work has been done in fitting the motor to other apparatus, all the way from music boxes and vacuum cleaners to pumps and cranes. Sometimes a specially designed motor is required and modifications are often made in the apparatus to be driven. The object and the end is effective adaptation. In electric heating devices the same activity is found. Special heating appliances are available for hundreds of purposes and in other cases standard or special heating units are made, which can be readily applied and to replace gas or steam in endless applications.

All of this indicates the trend toward specific adaptation. While this principle is acted on by the electric manufacturers and by makers of many other kinds of machinery which employ electric motors or heaters, it is only beginning to be recognized and acted upon by the general public in applying the apparatus.

(b) A careful study should be made of the operation which is to be performed. Sometimes the conditions are simple; at other times they are complex. Often the general arrangement of a mill or factory may be made entirely different if many motors instead of a single engine supply the power, or some simple difference in the form or position of motor driven tools may greatly facilitate the handling of material or the convenience of operation. In some instances where a constant and definite speed is important the actual speed with engine drive has been below the maximum on account of variable belt slippage whereas the steady, maximum speed secured by motor drive has resulted in an increased output of uniform quality—a result which alone justified the electrical equipment. In another case the removal of belts and overhead bearings from which oil was liable to drop on the expensive woven product has resulted in great saving. Instances might be multiplied to show how large are the indirect and in a sense the incidental features, which are apt to be overlooked.

(c) The cost of power is usually the first item which is considered. Sometimes it is the controlling factor, but often it is quite secondary as compared with other economies in electric methods. To the power user the cost problem is, in some cases, a double one; first, the relative cost of electric power and of steam power, and second, the relative cost of purchased power and of power produced in an isolated plant. The solution of the problem is not as simple as is its statement. Many of the factors which enter into the cost of power are quite difficult to determine. In a steam driven factory or mill the total annual cost of power may be fairly definitely known, but the cost per horse power hour is quite a different matter. The latter can be quickly calculated by assuming that the engine develops its rated output ten hours a day. But usually it does not, its load is fluctuating, the load factor is low, much of the power developed does not pass beyond the belts and shafting. It is easy to overestimate the actual useful power required, which determines the amount of electric power needed to replace the engine. A man who has a 100 horse power engine calculates that electric power at $60 a year would cost $6000; but the average load may not be over 30 or 40 h. p. and is sometimes much less.

Furthermore, the subdivision of a motor driven factory permits the shafting and machinery in parts which are not needed to be idle. Simple and obvious as these matters may be, yet they are apt to be overlooked, although they may be the really determining factors in making correct cost comparisons. The results of actual investigations have shown a surprisingly large number of cases in which cheaper power is obtained by the substitution of motors operated by central station power than from steam engines and even gas engines operated by natural gas.

(d) The total cost of operation by the old and by electric methods is one which involves far more than the first cost of apparatus and the cost of power. In general, the interest on the first cost of motors is small compared with the cost of current which they consume, and in nearly all ordinary applications in which labor is involved the cost of power is low compared with the cost of labor. Hence the prime object should be to increase the output of labor. Whatever conduces to rapidity, reliability or continuity, so as to reduce the labor cost by even a small fraction justifies a considerable increase in the cost of power. It may increase the rate of doing the work which the man directs, it may reduce the number of workmen required, it may by better illumination or ventilation in the mine, the factory, the office or the kitchen, increase the efficiency of the expensive human machine. If better light will enable the mechanic or the miner to do more work, or prevent the mistakes of a bookkeeper or a sewing girl, if electric cookers and washing machines and irons and sweepers enable one maid in the house to do what two did before, of what consequence is a few cents in the cost of current? But aside from the labor element almost every application of electricity is a working example of its indirect advantage in convenience and economy. What would appear less promising than

the running of a paper mill electrically instead of driving it direct from water wheels? And yet the electrical system is justifying itself because of simplicity, flexibility, convenience, ease of control and economy. What could be less promising than electric drive for a sawmill? And yet electric power is in some cases purchased from a central station and in other cases it is made in an isolated plant with satisfactory results from the standpoint of cost. If the substitution of a motor for a logging engine can prevent a forest fire now and then, questions of convenience and cost are of trifling consequence. If an electric locomotive in a mountain tunnel increases traffic capacity, removes congestion and delays, and does away with smoke and deadly gases, it matters little whether or not the saving in coal is equal to the cost of electric power.

And yet it is a common habit to lay great stress on the cost of current and to overlook or minimize other things. The relative cost of the electricity required for replacing a gas light or a steam engine or a gas heater, is to many people the controlling factor. A good example is found in a recent report on the "Adoption of Electrical Heat for Industrial Purposes" read before the last convention of the National Electric Light Association. The report is an admirable presentation of the subject, full of information and suggestion. An account is given of results with the use of electric soldering irons. In the making of tin lanterns each man had produced by gasoline heated soldering coppers 225 per day, and by the electric soldering irons each produced 300. The leaking seams were reduced from one in twenty to one in 200. The cost for the electric current was found to be less than ½ of that for gasoline. In other cases the cost of heating a soldering iron was about 19½ cents per day by gas and 12½ cents by electric current. About a page of the report deals with the relative cost of the electric current and less than two lines are devoted to the simple statement that the output is increased 33 per cent, then there is a summary as follows:

"These reports demonstrate that the electrically self-heated tools operate at an appreciably lower cost than it is possible for furnace heated irons, not taking into consideration the increase of working efficiency, absence of noxious fumes and heat, low installation expense, extreme compactness, portability, and reliable promptitude of action."

This sentence shows the importance which an expert committee seems to place upon cost of power, rather than upon other things.

If working efficiency, absence of noxious fumes, compactness and reliability are worth while, why not emphasize them and forget about the seven cents saving? This is a case where electricity at any reasonable price could compete with free gas.

This instance illustrates the general tendency to put electrical operation on a par with other methods by making the fundamental comparison one of cost. Without minimizing the importance of the cost of power, which in some cases is the controlling factor, it must be recognized that this kind of comparison is the most narrow and limited and it neglects what are often the greatest reasons for using electric power.

(e) The increased use of electricity is the vital problem before the central station. One of the first items to consider is that of rates. A fair rate per kilowatt hour when the whole income is derived from an evening lighting load is too high for a day load. A fair rate for a steady load of 10 hours or 24 hours is unnecessarily low for an intermittent load. The rate problem is as intricate and complex as it is vital, alike to users and producers of electric power, and it is receiving careful attention and varied solutions by central station managers. In general lower rates lead to increased consumption of power which in turn lowers the cost of furnishing power. Rates and extension of service are part of one problem—the complex engineering and commercial problem which some central stations are solving by new schedules of rates and systematic efforts for new business. Advertising and educational campaigns are being conducted by electric talks in the newspapers, by street car advertising, by house to house canvass and by the introduction of apparatus on trial.

The expert knowledge which is often essential to success must be supplied by experts. Moreover, conditions are changing. In our growing country with its big enterprises and its cheap materials the problem has been to make and to do at any cost; now we must look to efficiency and refinement of methods. The large manufacturing companies have specialists for studying methods and supplying data and advice to central stations and power users. Just as they are gaining the confidence of their clients so the central station should have proper advisers for its customers. Good salesmenship is not sufficient. The large electric manufacturing companies have found that the sales department as well as the designing department must contain men who are good engineers. The application as well as the generation of central station power must likewise be upon an engineering basis.

Where power is already produced in an isolated plant which the central station wants to supercede the situation often requires an engineering diagnosis, and an educational treatment. One manager who has made a specialty of substituting motors, says that he follows a friendly policy, the subject is taken up in successive stages, information as to the operation of other plants is furnished to the prospective purchaser of power, the conditions in his plant are investigated, his engine is indicated, the time during which individual parts of the plant are running is observed and a full report is made. Sometimes a year or two has been necessary for producing the desired result. Sales work of this kind requires different methods from those formerly used in making contracts for incandescent lighting. In some central stations the installation engineer is becoming an important member of the force. He studies the customers' conditions and needs. He advises regarding the lighting of stores and factories and residences, and consults with architects regarding location of lights in new buildings. He investigates and advises regarding the use of motors and the application of heating appliances. He acts for the interests of those who purchase as well as those who supply electricity and in the long run he serves both best when his first aim is to make the electric service satisfactory and profitable to the consumer. Fortunately the use of electricity is like leaven, it increases naturally. Small installations of motors are followed by larger ones, on account

of economy in power, the gain in general flexibility or in convenience of control. In the home the same rule applies. A friend recently remarked that a short time ago he had used electric light in connection with gas but now he has no need of gas. He has an electric iron, a motor on the sewing machine, an electric toaster and a motor driven vacuum cleaner, and he purposes to arrange to shift belts so that the motor can drive either the vacuum cleaner or the washing machine. Similar illustrations are found at every hand showing how automatic is the growth of the habit of electric living.

(f) Electric heating is in very much the same situation now as was the motor ten years ago. It has been regarded as something of a fad or a novelty and is just now being taken up in a general and serious way. Sometimes motors are used because they can apply power conveniently and effectively, and sometimes because they are a cheap source of power in large amounts. Likewise electric heating may be divided for convenience into two general classes, that in which quality is all important and that in which quantity is paramount. The quality class comprises applications where convenience, ease of control, absence of fire risk and of gases, are involved and includes most of the ordinary domestic and manufacturing uses. The other class, in which quantity of heat is involved, appertains to the heating of rooms or buildings or of large volumes of water, or ore, or metal. In the first the amount of power is small; in the second it may be very considerable. The first can use current at a fair price; the second is usually economical only at a very low price for current.

It is astonishing to find how very many kinds of heating applications there are, and a very little consideration shows what innumerable uses for current will come with the general introduction of heating appliances, which are already on the market. Heat in quantity will find many acceptable applications particularly where it can be used or stored during the hours of the day when the current could be employed for no other purpose. The use of heat on a large scale in the electric furnace is a rapidly developing application, which gives great promise of important uses in handling metals, particularly in the manufacture of steel. The general heating problem is one of great promise from all standpoints. It is one which needs sound engineering guidance and it promises to react upon the load factor and the power rates of the central station.

(g) The general problem of the application of electricity is comprehensive. It involves the design of apparatus for specific ends, which requires that the designer know what his apparatus is to do. On the other hand it calls for a re-adjustment of appliances and of methods, in the home and in the work-shop, which will adapt them to the new conditions which electricity supplies. It involves commercial relations between those who supply power and those who use it. It reacts upon central station load factors and costs and rates. It brings the central station into vital relation with the community. Instead of serving a single commodity for a few hours in the evening, it furnishes the energy which cooks the meals and sweeps the floors, which runs the cars and the elevators, which operates the grinders in the meat shop and the grocery, the mangles in the laundry, which heats the irons of the tailors and the chocolate of the candy maker, which runs the saw and the lathe and the planer, which serves the miner and irrigates waste lands. All this means a new relation between the electrical engineer and the community.

The electrical engineer is naturally a missionary. He has pushed forward conquering many fields in which he was but little welcome. This is noticeable on a large scale in the steel industry. It is not many years, since the motors in the steel mill, were regarded as suited only to run small cranes and the like, and not for the large and serious operations of the mill, but now in the greatest steel plant electricity is supreme, even the steam engine is no more. The electric system has transformed the method of producing power as well as the way of transmitting and using it, and the electrical engineer, who was not long ago operating a few arc lamps and repairing crane motors, is now brought to a most responsible position, having much to do with the design of the mill as well as its operation. What has been accomplished in the steel mill must be accomplished in the community. Electricity must emerge from a convenient means of doing a few things into the central operating system.

The output of coal—the power producer—has been a true measure of 19th century progress. Electricity is showing us how to transmit and apply power. We are just entering a new era in the use of power—of universally applied electric power. The fundamental conditions are auspicious, the possibilities are unlimited, and the outcome will be determined very largely by the ability with which we electrical men meet the opportunities which lie before us.

THE NEW ATOMIC THEORY.

There has been a tendency in some quarters to suppose that the development of physics in recent years has cast doubt on the validity of the atomic theory of matter. This view is quite erroneous, for it will be clear from the evidence already discussed that the recent discoveries have not only greatly strengthened the evidence in support of the theory, but have given an almost direct and convincing proof of its correctness. The chemical atom as a definite unit in the subdivision of matter is now fixed in an impregnable position in science. Leaving out of account considerations of etymology the atom in chemistry has long been considered to refer only to the smallest unit of matter that enters into ordinary chemical combinations. There is no assumption made that the atom itself is indestructible and eternal, or that methods may not ultimately be found for its sub-division into still more elementary units. The advent of the electron has shown that the atom is not the unit of smallest mass of which we have cognizance, while the study of radioactive bodies has shown that the atoms of a few elements of high atomic weight are not permanently stable, but break up spontaneously with the appearance of new types of matter. These advances in know ledge do not in any way invalidate the position of the chemical atom, but rather indicate its great importance as a sub-division of matter whose properties should be exhaustively studied. There can be little doubt that the atom is a complex system, consisting of a number of positively and negatively charged masses which are held in equilibrium mainly by electrical forces.—Prof. E. Rutherford.

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POWER AND GAS

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FOUNDED 1887 AS THE
PACIFIC LUMBERMAN, CONTRACTOR AND ELECTRICIAN

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The gross income from national forests in California is nearly $120,000 annually, one-fourth of which is applied to the State school and road funds.

Those who can attend the sessions of the Pacific Coast Gas Association during the first part of next week will be amply rewarded by hearing interesting papers to be read. Those not so fortunate as to attend will find these papers in our next issue.

Yeoman's service is being rendered by many an employee of hydro-electric power companies in fighting the fierce forest fires that are now sweeping through several of the Western States. Unfortunately, the annual re-occurence of such wasteful disaster has become as regular as the spring floods.

That conservation means more than the mere hoarding of natural resources is shown in a paper recently read before the Canadian Electrical Association by S. E. Doane, chief engineer of the National Electric Lamp Association, wherein he skillfully suggests that the tungsten lamp lessens fuel waste.

From present indications it will not be long before we can answer the question "What is electricity?" Recent scientific investigation points to a molecular theory of electricity as the hypothesis best fitted to explain the many evidences of the close relationship between electricity and matter.

In the course of his letter vindicating Secretary Ballinger of the charges of wrong-doing in connection with the Alaskan coal lands President Taft states: "In my judgment he is the best friend of the policy of conservation who insists that every step taken in that direction should be within the law and buttressed by legal authority. Insistence on this is consistent with a whole-hearted and bona fide interest and enthusiasm in favor of conservation. From my conferences with you and from everything I know in respect to the conduct of your department, I am able to say that you are fully in sympathy with this Administration's attitude in favor of the conservation of natural resources."

The vexed question of rates, like the problem of the poor, is always with us. At every commercial convention this subject has necessarily been left unsettled because no system of charging for electric service yet devised is of universal application. Perhaps one of the best proposed is the "readiness to serve basis" presented by M. C. Osborn of the Washington Water Power Company at the Seattle Convention last week. This estimate was based on an exhaustive analysis of thousands of accounts and involved a vast amount of detail work, yet withal it is strictly applicable only to the city of Spokane, for which it has been calculated. As a model for other localities it is useful, but the final rate for each city must ultimately be worked out independently.

Trend of Electrical Development

Probably the most inspiring paper read at the Joint Convention of the Northwest Electric Light & Power Association and the Seattle Section of the American Institute of Electrical Engineers was that by Charles F. Scott, Past President of the Institute, in which he outlines the trend of electrical development. This article may be regarded as authoritative as it comes from a man of such national prominence. It is likewise essentially practical, telling of what is being done and leaving the reader to infer the boundless possibilities of the application of electricity to modern life. The author starts with the assumption that the old difficulties of generation and transmission have been so successfully minimized that the great field for endeavor yet remaining is one of utilization.

His theme throughout is an exemplification of the economic substitution of electricity in every industry requiring light, heat or power. Emphasis is laid on the many indirect advantages of electric current which would cause it to be used, even if other sources were supplied free of charge, since every application of electricity is a working example of its convenience and economy. Finally the trend of electric development to specific adaption should prove an incentive to devise new applications of the "habit of electric living."

Ethics for the Illuminating Engineer

Many central stations have added an illuminating engineer to their staff primarily to produce satisfaction among their consumers. Incidentally they can thus reduce the lighting peak by giving better light with less current. With these facts in mind, it is difficult to understand the attitude taken by some illuminating engineers employed by central stations who think that their compensation is dependent upon increased use of current caused by their recommendations. If the least suspicion of this should enter the lay mind all confidence would be destroyed and an illuminating engineer employed by the lighting company would be worse than useless.

No man can serve two masters. If his salary is being paid by the central station it should be with the distinct understanding that the effect of his suggestions upon the company's income is of but secondary importance. Anything that improves the quality of service rendered by a public utility corporation is of far greater value than a mere temporary increase in income. Illuminating engineering fails in its purpose if it does not provide the most economical use of the energy. The satisfaction given to consumers more than compensates for a reduction in rates, as it means more business in the future. The motives of the illuminating engineers should resemble the requirements for Caesar's wife, and the ethics by which he must be guided required strict independence of commercialism. He should realize that by looking out for the present customers the future ones will come the readier.

Secrecy in Engineering

Suppose that the proofs by which Dr. Cook and Commander Peary hope to establish their claims of having reached the North Pole were destroyed before being made public. Would not the most vital part of their expedition be lost? Suppose that either party had been killed while returning from the goal and left no record. Would the world know of their achievement? What is true of reaching the North Pole is true of any thing done by any one. Unless others know what we have done and how we did it the full measure of success is not attained.

To be effective, work should be evident. Unrecorded work is much like the wattless current consumed in an induction motor at no load. This current does no work and it decreases the output of the generator. To repeat ourselves, a clock without hands is no more useless than a worker without expression. Such expression may take many forms; it may be written or it may be oral, or it may stand as a great dam, proclaiming the ability of the designer and remaining as a monument to his skill.

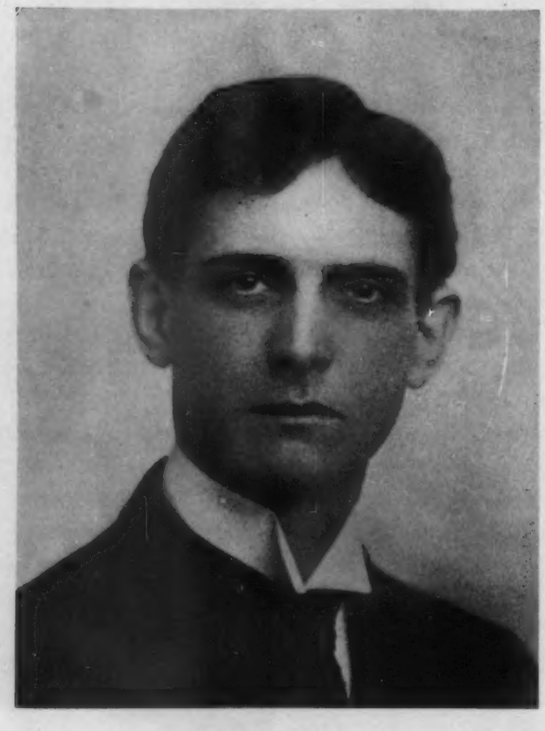
Knowledge like power, frequently runs to waste. The untimely death of some great man who has not grasped the opportunity to give to the world the results of his own experience is a distinct loss to the world and a greater one to the individual whose memory might otherwise live long after the more tangible evidences of his ability were destroyed. There is nothing so wasteful as the re-duplication of effort in learning by personal experience what some one else already knows but refuses to divulge.

The reasons for such refusal are many. Modesty sometimes forbids a man from expressing himself, fear of criticism or apprehension that it will not be accepted in the spirit in which it is presented sometimes checks expression. Commercial exigencies place the seal of secrecy on the lips of corporation employees. But fundamentally the cause is selfishness and disregard of the fact that "my light is none the less for having lit that of my neighbor." Mutual interchange of technical knowledge enriches all and impoverishes none. This selfishness is directly antagonistic to the fine conception than man's value to society, depends upon the impetus he may give to the advancement of human progress. We should all regard ourselves as cogs in a great machine which would soon be stopped by the friction of the universal secrecy.

JOURNAL PORTRAITS

Charles W. Burkett came to the Pacific Coast in January, 1908, as the chief engineer of the Pacific Telephone and Telegraph Company. His enviable record for five years previous as the organizer and head of the engineering department of the Wisconsin Telephone Company set a high standard of excellence that has been even exceeded by his work in the West.

Like most successful men in the telephone service, Mr. Burkett started at the bottom, beginning as wireman's helper in the employ of the Southern Bell Telephone Company in 1896 after graduating from the department of electrical engineering of Pennsylvania State College. Within less than six years he advanced to the position of assistant engineer for the Southern Bell Company, resigning in 1902 to enter the



Charles W. Burkett.

employ of the American Telephone and Telegraph Company's engineering department at Boston. As already stated, in 1903 he took charge of the engineering work of the Wisconsin Telephone Company, organizing the engineering department and remaining as its head for five years.

Mr. Burkett is an active member of the American Institute of Electrical Engineers, the San Francisco section having enjoyed the advantages of his chairmanship during the year just passed. He is now a member of the executive committee and chairman of the paper's committee. His duties, which take him all over the Coast, have been the means of introducing him to a host of electrical men, every one of whom value him as a friend.

OBITUARY.

George W. Dickinson, president of the Pacific Engineering Company, of Seattle and Portland, died September 2, from pneumonia. He was born in Cleveland, Ohio, in 1853. In 1897 he became manager of the Seattle Electric Company, resigning this position to take up private work.

PERSONALS.

K. G. Dunn of Hunt, Mirk & Co., is in the Northwest.

F. H. Gale, manager of publicity for the General Electric Company is in San Francisco this week.

Geo. R. Murphy, San Francisco engineer of the Electric Storage Battery Co., is back from a brief vacation.

Thomas Mirk of Hunt, Mirk & Co., San Francisco, is taking a short trip throughout Southern California.

A. J. Myer, district manager of Wagner Electric Manufacturing Co., on the Pacific Coast, is in Los Angeles.

John R. Cole and John Sutton returned last week to San Francisco from an extended trip throughout the East.

Leo Vander Naillen, manager of the Oro Light & Power Co. of Oroville, was a visitor at the State Fair at Sacramento.

Frank Fowden, manager of Brooks Electric Corporation, San Francisco, was in the San Joaquin Valley during the past week.

R. B. Daggett, manager of the Pacific Coast offices of the Electric Storage Battery Co., has returned to San Francisco from Seattle.

Charles F. Scott, consulting engineer of the Westinghouse Electric Manufacturing Co., East Pittsburg, Pa., is in San Francisco.

J. W. White, Pacific Coast engineer for the Fort Wayne Electric Works, is taking a trip through the California northern mining counties.

Professor Morgan Brooks of the University of Illinois will sail from San Francisco on the new Japanese turbine steamship Tenyo Maru on October 12.

C. P. Baird, manager of the King City Water, Light & Power Co., was in San Francisco this week; he also was a visitor at the State Fair at Sacramento.

George R. Fields, for many years contracting engineer with the Risdon Iron Works, has resigned his position to become assistant general manager of the Great Western Power Company.

C. S. Cook, manager of the railway and lighting department of the Westinghouse Electric & Manufacturing Co., of East Pittsburg, Pa., is in San Francisco this week on a trip through the Western States.

Irving C. Harris, for nine years with the Edison Electric Company of Los Angeles has succeeded the late A. H. Demrick in charge of the construction and operation of the U. S. Reclamation power transmission system in the Salt River Valley, Arizona.

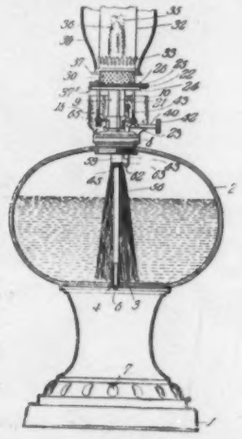
Ralph W. Pope, secretary of the A. I. E. E., accompanied by Past President Charles W. Scott and Vice-President Paul M. Lincoln, was in San Francisco during the past week. In honor of their visit the San Francisco Section of the A. I. E. E. gave an informal dinner at the Old Poodle Dog Restaurant. Mr. Pope and Mr. Scott spoke informally on matters devoted principally to institute affairs, which on account of their long familiarity and experience, proved most interesting. On his return home, Mr. Pope will visit Los Angeles and Salt Lake City, attending the Street Railway Convention at Denver on October 1st, proceeding thence to St. Louis. At all these places arrangements have been made for special meetings, so that the Secretary can meet as many members as possible.

TRADE NOTE.

Hughson & Merton, manufacturers' agents, formerly at 438 Market street, have removed to 544 Van Ness avenue, near Golden Gate avenue, San Francisco.

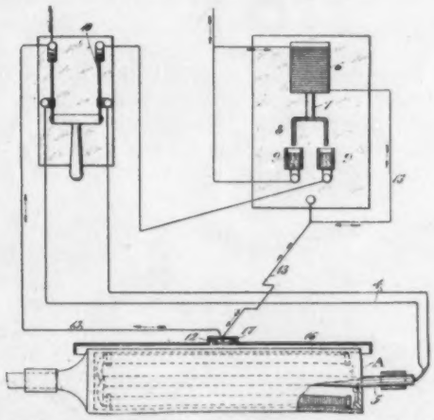
PATENTS

932,486. Incandescent Lamp. Robert Matheson, Quartzsite, Ariz. In a lamp a main tube, adjustable rods supported thereby, a ring fixedly connected to and movable with the



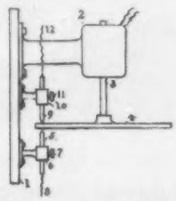
rods, said rods and ring being shiftable longitudinally of and guided by the tube, and a gallery pivotally mounted upon the ring and movable laterally out of normal position when the ring is elevated.

932,966. Electrothermostatic Heat-Regulator. Lloyd G. Copeman, Berkeley, Cal. In an apparatus of the character described, an electrical heater, a cut-out in the main circuit, an auxiliary or shunt circuit, a thermo circuit, closer interposed



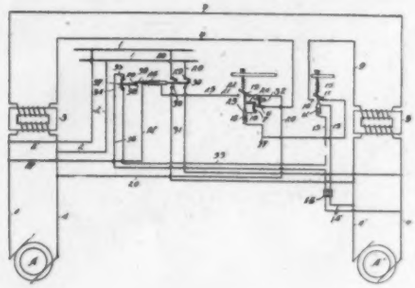
in the auxiliary circuit independent of and exterior to the heat zone of the heater, a stationary hood arranged proximate to the heater having a depressed chamber, and a thermostat in said chamber fixed to the inner wall thereof, and exposed directly to the heat radiating from the heater.

932,541. Abnormal Potential-Discharging and Arc-Disrupting Device. Frederic W. Erickson and Frederic W. Lord, New York, N. Y. An abnormal-potential discharging and arc-



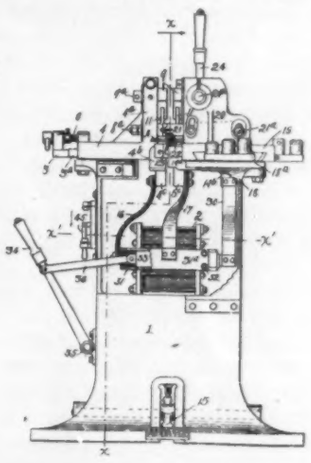
disrupting device comprising two elements mounted in a current path extending from the portion of the circuit to be protected to the ground, one of said elements comprising an arc-dissipating device of larger area than a cross sectional area of the current path to provide an extended dissipating path, portions of which are successively positionable within the current path, and one of said elements being constantly movable, the planes of the faces of said elements being parallel with each other and remaining substantially unchanged relative to each other, the successive positioning of any given point of the dissipating device within the current path being at spaced time intervals of sufficient length to permit the remaining dissipating portions to be positioned within the current path.

932,877. Automatic Synchronizer. Howard Marshall, Vance, Colo. The combination with an alternating current circuit, of an incoming machine, conductors connecting the machine and circuit, a closing switch controlling the continuity of the conductors, an electro-magnet connected to the closing switch for controlling the switch, a synchronizing



switch comprising operated and operating members, the operated member connected with the electro-magnet when the synchronizing switch is closed and causing the electro-magnet to operate the closing switch, a secondary or trip circuit, a resistance therein, means actuated by the operating member of the synchronizing switch for controlling the resistance and means for controlling the secondary circuit.

932,441. Electric-Welding Machine. Alvin E. Buchenberg, Toledo, Ohio, assignor to The Toledo Electric Welding Company, Toledo, Ohio. In an electric welding machine of the class described, the combination of separate work carrying



means, a single transformer having its secondary in connection with such means, and mechanism operative to cause the secondary current to flow through one or two articles held by said separate means, when such articles are spaced and through both when the articles are in contact.

INDUSTRIAL

Exhibit of General Electric Co. at A. Y. P. Exposition.

GENERAL ELECTRIC COMPANY'S EXHIBIT AT A.-Y.-P. EXPOSITION.

The exhibit of the General Electric Company, covers an area of 1,400 square feet in the Machinery Hall. This space is divided into open floor space and a booth, the latter consisting of two rooms, a reception room, which is handsomely furnished and occupied as the headquarters of the N. W. Electric Light & Power Association, and a show room in which is displayed a complete line of electric heating and cooking devices.

On the open floor space are shown the larger electric exhibits, including a 6½ ton mining locomotive possessing a number of new features; a motor generator set controlled by a self starting automatic compensator, and new designs in fan motors. In addtion to their usual line of transformers, two new designs of particular interest are shown, one being a bell ringing transformer, which may be connected to the lighting current in buildings and used for wiring door bells or any such service; the other being a compensator, transforming from 110 to 220 volts to low voltage, for use with tungsten lamps.

A new form of solenoid-operated high tension oil switch, the rating of which is 45,000 volts, gives remote or hand control and has a rupturing capacity of 20,000 k. w. and above; this is the smallest switch of that type, others being suitable for controlling circuits of 70,000 and 110,000 volts. A great variety of direct current apparatus is shown, including motors, arc lamps and large solenoids for oil switches and circuit breakers, all being operated satisfactorily from a mercury arc rectifier.

On exhibition is a new type of clutch armature for induction motor, the special feature being that the armature runs free on the shaft until it has attained sufficient speed to pick up the required load. There is a large display of rheostat controlled apparatus, also new intensified arc lights, and numerous small apparatus of new and recent design. An automatic motor starter controlled by float switch is also shown. Numerous wiring devices, meters and other instruments are exhibited; they also have very attractive board displays of

Exhibit of Electric Heating Appliances.

wires and cables, railroad line material, rail bonds, etc. They also show a large assortment of motor attachments for pumps, coffee grinders, sewing machines, meat choppers, etc. This exhibit is under the supervision of Mr. J. E. Hill, Jr.

LOW PRESSURE STEAM TURBINES.

The possibility of getting something for nothing has been realized in the low pressure turbine. Exhaust steam from engines driving generators, line shafting, hoists, and in fact anything where steam is used in sufficient quantities, whether the consumption be regular, as for pumps, refrigerating machinery, etc., or intermittent as with mine hoists and apparatus having a varying load, may be utilized for driving low pressure steam turbines, having a capacity approximately equal to the steam engines from which the exhaust steam is used. The additional power thus obtained costs practically nothing, because this power is obtained at no extra expense for fuel, the total operating cost being interest on investment, depreciation, and attendance.

There has been much discussion on the subject of low pressure turbines and many articles have appeared in the technical journals, and considerable interest has been shown in the development of the apparatus. Several installations of this character are now in successful operation and the claims of the manufacturers have been substantiated.

The Pacific Lumber Co. have shown their faith in low pressure turbines, by ordering an equipment from the Westinghouse Electric & Manufacturing Co. to be installed in the new mill which they are erecting in Scotia, Humboldt Co., California. This equipment consists of a Westinghouse-Parsons low pressure turbine direct connected to a 300 k. w. Westinghouse, alternating current generator, 3 phase, 60 cycles, 2200 volts, 3600 r. p. m. Turbine takes exhaust steam from two Nordberg Twin Engines, having a normal capacity of approximately 1250 h. p. These engines take steam at 100 pounds pressure, exhausting directly into the low pressure steam turbine from which the steam is conveyed to the Leblanc condenser. The generator is excited by a 17 k. w. Westinghouse engine type generator, 125 volts, direct connected to a Westinghouse steam engine. Current from this generating set will be used to drive approximately 100 h. p. in motors, which will be used in various parts of the mill and for light about the town and mill.

The switchboard consists of a generator, and exciter and a feeder panel in the station, and a distributing panel which will be placed in the old saw mill for handling current for lights and power in the older part of the town as well as the old mill. These panels were also furnished by the Westinghouse Electric & Manufacturing Co. Leblanc Condensers are manufactured by the Westinghouse Machine Co. and its high efficiency and good operating qualities have won for it an enviable reputation.

Although there are a number of low pressure generating sets in operation in the East and in foreign countries, as yet there are few on the Pacific Coast, but a large number of manufacturers are now negotiating with the manufacturers for plants similar to that furnished the Pacific Lumber Co. Where the power demands of the generating station of an industrial establishment exceeds the generating capacity, the installation of a low pressure steam turbine provides the necessity additional power with only the expenditure required for a low pressure turbo-generator, and condensing apparatus.

As very little room is required for such an equipment there are few places where such an installation would be impracticable due to lack of space. Mr. Ralph Bennett of Los Angeles, served as consulting engineer for this installation, and Hunt, Mirk & Co. of San Francisco made the contract for turbines, condensers and exciter sets. The contract for switchboards being awarded to the Westinghouse Electric & Manufacturing Co.

TRADE NOTE.

Harron, Rickard & McCone have moved their offices from the Sheldon Building to their new quarters on Townsend street, San Francisco.

NEW STEEL TIE AND SPLICING WRENCH.

The purpose of this wrench is to "tie in" the line wire to the insulator. In practical use, the tie wire already bent in the customary U shape is slipped over the insulator with the open end of the U resting on the line wire; then one of the ends of the U is put through the hole in the eye, and the tool shoved back against the line wire. Then by a rotary movement of the wrench around the line wire, it curls the tie wire around the line wire in the form of a spiral. The other end of the U is then treated likewise, and the line is permanently fastened to the insulator. Linemen ordinarily do this work with pliers, but the wrench is a time-saver, and makes a clean, solid job, and without danger of nicking the line wire. The splicing end is intended for use along with the splicing clamp. The ends of the wires to be connected are held with the splicing clamp, and the projecting end is caught with the shoulder of the wrench, and by turning the wrench around continuously, it will coil the wire tightly and evenly on the line wire, making a clean, tight splice. Made for the following size wires for tying in with Numbers 7 to 11 copper wire, and splicing Numbers 4, 6, 8, 9, 10, 12 iron wire, or for Numbers 2-4, 10 6-8, 10-12 copper wire. The above wrench is 7 inches over all, and is manufactured by Mathias Klein & Sons, Chicago, Illinois.

NEW CATALOGUES.

Holophane Illumination for August, 1909, from the Holophane Company, Newark, Ohio, containing a number of interesting articles on Industrial Lighting.

The Gray Telephone Pay Station Company, Hartford, Connecticut, send a handsome booklet of testimonials from various telephone companies, regarding this company's device for the collection of telephone charges without the use of an attendant.

GIFT TO INSTITUTE LIBRARY.

The Western Electric Company has presented to the library of the American Institute of Electrical Engineers a most valuable addition in the shape of a patent specification library. This gift constitutes the largest accession since the original creation of the library by Dr. S. S. Wheeler with the Latimer-Clark collection.

The patent library which the Institute thus acquires contains no fewer than 461 substantial leather-bound volumes containing approximately 100,000 specifications. These specifications begin with May 30, 1871, and run to December, 1908, thus covering the entire period of activity which includes the telephone, the electric light, electric railways and the electric motor. From May 30, 1871, up to the last day of 1887 the volumes are complete, containing all the specifications issued by the Patent Department, certified. From July, 1887, up to December 1, 1908, the volumes contain all the electrical specifications which are not certified.

BOOKS RECEIVED.

"Elementary Electrical Calculations." By T. O'Conor Sloane; 300 pages; 8x5. Published by D. Van Nostrand Company, New York, and for sale by the Technical Book Shop, San Francisco. Price, $2.00.

This text is designed to simplify the study of electrical calculations, eliminating as far as possible the higher mathematics. The treatment of direct current phenomena is complete almost to the point of diffuseness, but the numerous examples presented should give excellent training to the student. It brings into compact form much information on the elements of mathematics, physics, mechanics, chemistry, magnetism and electricity. It presents the basis of alternating current mathematics and treats of several typical simple problems. It will be found valuable by all students interested in the mathematical side of electricity.

NEWS NOTES

FINANCIAL.

ASHLAND, ORE.—At a recent election the proposition to bond the city for $50,000 for a water system carried.

SAN BERNARDINO, CAL.—The Upland Gas Company plans for extensive improvements in that section of the county. The company has launched a $25,000 bond issue to cover expenses.

VALLEJO, CAL.—It has been determined by the Board of City Trustees to call a special election at an early date at which the proposition of bonding this city for $70,000 will be submitted to the people.

WILBUR, WASH.—The State was the successful bidder for the water works bonds amounting to $4,100. Bids will be advertised for at once for the furnishing of the town with iron pipe and fixtures to renew the mains of the system.

RIVERSIDE, CAL.—The City Council has passed an ordinance calling an election to be held on October 5th to submit the proposition of issuing bonds for $5000 to be used for the construction of a reservoir and water pipes and hydrants on Arlington Heights.

FOREST GROVE, ORE.—The Supreme Court has passed on the issuance of the $70,000 bonds for the city and a decision has been handed down affirming the decree entered sometime ago by Judge J. U. Campbell of the Circuit Court of Washington county, declaring the bonds valid.

SAN FRANCISCO, CAL.—An increase in the capital stock of the Sunset Telegraph and Telepone Company from $3,000,000 to $6,000,000 is acknowledged in a document filed with the County Clerk. The increase is for the purpose of general development of the company's lines, and was voted at a meeting of the directors held August 18th.

SAN FRANCISCO, CAL.—The directors of the Mojave Water & Power Company has voted to increase the bonded indebtedness of the company by $15,000,000. Among those interested in the company are Julian Mathieu, Harry C. Mack, Francis C. Van Deinse, Charles F. Metteer, Chauncy S. Goodrich and A. E. Boynton. The bonds (5 per cent) will be dated September 1, 1909, and are due and payable in 1949. Attorney A. E. Boynton states that the company increased its bonded indebtedness at this time, not to sell bonds, but for the purpose of being in readiness to do so in after years. The present law requires at least 90 days to increase a bonded indebtedness, and the directors thought it advisable to do so at this time.

ALBANY, ORE.—The Willamette Valley Company has deeded to the Northwestern Corporation all of its property in Oregon. Enumerated are the electric light plants of Albany, Corvallis, Springfield, Eugene, Dallas, Monmouth and Independence, the water supply systems at Albany, Springfield and Independence and the gas plant at Eugene. A mortgage has been filed by the Northwestern Corporation to the Germantown Trust Company of Philadelphia for $5,000,000. It covers all of the property mentioned in the deed to the Northwestern Company from the Willamette Valley Company, and in addition includes the street railway system of Walla Walla, Wash.; the interurban line between Walla Walla and Milton, Ore., the power plant in Umatilla county, which transmits electric current to Walla Walla and Pendleton, Ore., the electric light and gas plant at Walla Walla and Pendleton, and the gas plants at North Yakima, Wash., and Lewiston, Idaho.

INCORPORATIONS.

PORTLAND, ORE.—Pacific Gas Traction Company of Portland, $1,000,000 by C. P. Miller, C. A. Bell and Sanderson Reed.

MARSHFIELD, ORE.—The Catching Inlet Telephone Company has been incorporated with $500 capital by William I. Bonebrake, James S. Masters and Alfred Gunnel.

SAN FRANCISCO, CAL.—Los Vaqueros Oil Company, capital stock $500,000, shares $1 each, subscribed $5, by H. B. Leigh, A. C. Smith, F. L. McLellan, F. A. Taylor and Wm. Bemenderfer.

TELEPHONE & TELEGRAPH.

DOWNIEVILLE, CAL.—A telephone line is to be built from Camptonville to the mining camp of Brandy City.

BRIDGEPORT, WASH.—The Pearl Telephone Company has been organized. Scott Coleman was elected president.

ONTARIO, ORE.—The Ontario Independent Telephone Company is negotiating for the installation of its plant here.

BELLINGHAM, WASH.—The system of the Farmers' Mutual Telephone Company in Whatcom county is to be improved.

SAN FRANCISCO, CAL.—Certification of the increase of the capital stock of the Sunset Telephone & Telegraph Company, from $3,000,000, divided into 30,000 shares of $100 each, to $15,000,000, divided into 150,000 shares of $100 each, was filed with the county clerk last week. The resolution authorizing the increase was adopted at a meeting of stockholders at Martinez, August 13, 1909.

ILLUMINATION.

GLENDORA, CAL.—The City Trustees have opened bids for $40,000 worth of electric lights.

ORLAND, CAL.—The voters of Orland have decided in favor of levying a special tax to maintain street lights.

TONOPAH, NEV.—The Nevada Gas Company is considering the building of a gas pipe line a distance of 28 miles to Goldfield.

UNION, ORE.—At the election last week it was voted to issue bonds for the purpose of establishing a municipal lighting plant.

SEATTLE, WASH.—The Board of Public Works has granted the Forbes Electrical Supply Company a contract to supply the city with incandescent lights.

PORTLAND, ORE.—The Seventh Street Improvement Association is making plans to light Seventh street from Jefferson to Couch street and everything is ready to let the contract.

FRESNO, CAL.—The San Joaquin Light & Power Company will spend one million dollars on a water and electric light and power plant for Coalinga, according to President A. G. Wishon.

LOS ANGELES, CAL.—The Board of Supervisors will receive sealed bids up to September 20th, for installing and maintaining for a period of five years, a lighting plant in the East Hollywood Lighting District.

MONROVIA, CAL.—Electroliers for the lighting of Myrtle avenue from Olive street to the City Park are now practically assured, as property owners representing more than half the entire frontage in the lighting district, have agreed to pay for the installing of lights.

VALE, ORE.—The Vale Light & Water Company has been sold to R. C. Carter, manager of the Idaho Electrical Supply Company of Boise. He was also granted a franchise by the Council to pipe the town with cold water, work on the system to begin within a month.

LOS ANGELES, CAL.—An authorization by the stockholders of Los Angeles Gas & Electric Company for raising $15,000,000 by a bond issue marked a meeting held last week. Of this $11,0000,000 is to be used in developing the plants of the company to keep pace with the growth of the city.

TOKOA, WASH.—At a recent meeting of the City Council a contract was entered into with the Idaho & Washington Light & Power Company for the lighting of the streets of Tokoa. The length of the contract is for five years, and according to the contract the company is to furnish a minimum of 25 lights at $2.50 per month each.

TRANSPORTATION.

LOS ANGELES, CAL.—The Pacific Electric will extend its road 12 miles from La Habra Valley eastward.

SAN DIEGO, CAL.—An electric street railway franchise will be sold on K to R and Twenty-fifth streets.

SAN FRANCISCO, CAL.—The United Railroads has purchased four acres of land from the Partridge estate on which it intends to erect a new power plant.

COLUSA, CAL.—George E. Springer, representing the Northern Electric Company, has asked that the company's franchise be extended for another year.

VALLEJO, CAL.—It is reported that the Vallejo and Napa Electric Railroad Company will erect a depot at the Main street wharf in the very near future, at a cost of about $25,000.

BELLINGHAM, WASH.—The Whatcom Railway & Light Company will start work on the Happy Valley extension as soon as practicable and the line will be ready for operation in another 30 days.

SANTA ROSA, CAL.—Mayor James H. Gray and Secretary F. H. Brown of the Santa Rosa Chamber of Commerce are securing rights of way from property owners for the Santa Rosa and Clear Lake Scenic Railway.

PACIFIC GROVE, CAL.—E. H. Kramer, president of the Monterey County Gas & Electric Company, which corporation owns the Monterey and Pacific Grove electric line, states that it is the intention of his company to double track and standardize the gauge of the road in the near future.

LOS ANGELES, CAL.—As the result of a thorough investigation of the pay-as-you-enter car system while in the East, President H. E. Huntington has decided to remodel every coach of the Los Angeles Railway Company., and this will be begun immediately. The main objects are the elimination of platform accidents which compose 75 per cent of the total occurring; the collection of fares, and maintain schedules.

STOCKTON, CAL.—The Central California Traction Company, which operates a street car line in this city, and an interurban line between here and Lodi, now being extended to Sacramento, will endeavor to construct a feeder to Linden and Bellota, a distance of 17 miles, before the promoters of the Stockton-Jenny Lind road have their line in operation. The proposed line will tap the rich farming and dairying section east of this city. The traction company has had men looking over the proposed right of way for some time. The United Investment Company, which is promoting the other road, has its rights of way secured.

SANTA ROSA, CAL.—Rights of way have been secured through Alexander Valley, in this county, and on to Preston for the Sonoma County and Lake County Railroad, a standard gauge electric railway to be built from Santa Rosa to Lakeport, in Lake county. Colonel J. E. Fulton of Lakeport states that the bonds of the new railroad are already contracted for. Rights of way for the Santa Rosa and Clear Lake Railway, another electric to run by a scenic route from Santa Rosa to Clear Lake, are also being secured, many of them being given free of cost.

SAN FRANCISCO, CAL.—At a conference between members of the improvement clubs and General Manager Black of the United Railroads, a decision was reached as to what extensions should be built immediately. Mr. Black said that the company would build the following extensions: On Army street, from Kentucky to Kansas street, and along Kansas to Twenty-fourth, which would furnish crosstown facilities between the Mission and the Potrero. On Hunter's Point Peninsula, along Seventeenth street from Kentucky to G street. Through the University Mound district from the Mission street line by a viaduct to Cambridge street, along Cambridge to Wayland avenue along Wayland to Amhurst street along Amhurst to Woolsey, and along Woolsey to and connecting with the San Bruno avenue line.

TRANSMISSION.

CHIHUAHUA, MEX.—Plans have been completed by the Nazas River Power Company to build a hydro-electric power plant in Fernandez canyon on the Nazas river.

ALAMOGORDO, N. M.—The High Rolls Company is getting ready to build its power plant which is to furnish power for the new trolley system, and for different pumping stations in the valley.

MONUMENT, ORE.—A company headed by H. V. Gates has filed water rights on the John Day river, about twelve miles above Monument, for the purpose of constructing a power plant to supply Heppner with light and power.

EUGENE, ORE.—J. B. Morris of this city has been awarded the contract by the City Council to build the transmission line for the new municipal power plant. The contract price is $3642. The length of the line will be about 15 miles. Work is to begin at once.

NAVY YARD, PUGET SOUND.—The navy department has awarded a big contract for the installation of a piping and circulating system in the new half million dollar central power plant being erected at this yard to the D. Polier Engineering Company, of Philadelphia, Pa., for $37,950.

WALLA WALLA, WASH.—The property and holdings of the Pasco Power & Water Company, of Pasco, Wash., have been transferred to a group of Seattle capitalists, who have organized a new company under the name of the Burbank Power & Water Company. The properties transferred include valuable water rights on the Snake River at Five Mile Rapids, four miles above Pasco, and several thousand acres of land on the Columbia River in the fruit belt. They also include a water-power plant, irrigation system and townsite at Burbank in Walla Walla County. James D. Hoge is president of the new company. An issue of $500,000 in bonds will be made.

WATERWORKS.

MONROVIA, CAL.—The installing of new water mains under the appropriation of $16,500 bond money voted recently will be done at once by the city water department.

PORTLAND, ORE.—Sealed proposals are being received by the City Council of the city of Newport, Lincoln county, for the construction of a water works system for the city.

TACOMA, WASH.—Wright & Sweeney have been awarded a contract to lay water mains in section 30 for $34,100 by the Commissioner of Public Works, H. J. McGregor.

SANTA CRUZ, CAL.—Five bids were tendered for pipe advertised for by the Supervisors. The contract was awarded to Byrne Bros. of this city, the lowest bidders, for $510.72.

PORTLAND, ORE.—Sealed proposals are being received by the City Council of the city of Newport, Lincoln county, for the construction of a water works system for the city.

PORTALES, N. M.—The Western Construction Co., of Wichita, Kansas, has entered into a contract to furnish adequate machinery and construct a power house to irrigate 6,000 acres in Portales Valley.

SAN DIMAS, CAL.—Charter Oak is to have a new domestic water system to be installed by the San Dimas Irrigation Company. The new reservoir is to be erected near the site of the present storage reservoir.

LAS VEGAS, NEV.—In an attempt to secure artesian water at Las Vegas, land owners in that desert have combined and will make an effort to locate water within a short time. A boring outfit is already on the ground.

TACOMA, WASH.—The special water committee has finally decided to abandon the South Tacoma wells and Clover creek project as a source of city water supply and build a gravity water system from Green river.

HOLTVILLE, CAL.—The Imperial city trustees have adopted plans of Consulting Engineer A. L. Sonderegger of Los Angeles for construction of a new municipal water system for which bonds were voted several weeks ago.

PORT ANGELES, WASH.—W. W. Seymour has been granted a 23-year extension of his water franchise. He will begin in about 30 days building a water system that will take its supply from Ennis creek and will supply the entire city.

GLENDALE, CAL.—The Glendale Independent Water Company has bought out the interest of L. R. Brand in the Miradero Water Company, and the new owners will lay a 10-inch main from First street to the western side of the city.

PASADENA, CAL.—Steps have been taken by the Council to obtain new options on water plants and properties. The Mayor has announced a new water committee to take immediate steps to secure new options on water properties at the best possible figures.

LOS ANGELES, CAL.—Sealed bids will be received by the Board of Water Commissioners up to September 7th for approximately 1632 feet of riveted sheet steel pipe. The Board will also receive sealed bids at the same time for approximately 6400 feet of sheet steel pipe.

CHICO, CAL.—The Chico Water Supply Company has completed its South Chico well, driven to a depth of 603 feet. This is the third well sunk in the last year, all to a depth of 600 feet or over. A pump will be installed soon, but the well may not be used until next spring.

RENTON, WASH.—The City Council has authorized the city clerk to ask for bids for the improvement of the city's water system. The work will include the furnishing and laying of approximately 15,000 feet of 14-inch pipe and the construction of one 500,000 gallon concrete reservoir.

ALAMEDA, CAL.—Sealed bids are being received by the City Clerk for furnishing all the material and labor for the construction of and the installation of an auto-pneumatic water supply system, to be installed in Washington Park, at the southwest corner of Central avenue and Eighth street.

GALLUP, N. M.—The following bids for the $20,000 water system, sewer system and street improvement bonds have been received by the Board of Trustees: J. H. Causey & Co., Denver; Beasley & Wells, Gallup, N. M., $20,425; Arthur Seligman, Santa Fe, N. M.. $20,400; R. A. Kean & Co., Chicago, $20,020. The bid of Beasley & Wells was accepted.

SALT LAKE CITY, UTAH.—By the action of the City Council last night the fourth precinct, comprising the northwest bench section of Salt Lake City, will get its new water mains. The improvements voted will cost in the neighborhood of $175,000. The work will go to Doyle Bros. & Schwartz, who have a contract with the city for the year's work.

COTTAGE GROVE, ORE.—As a temporary relief it is proposed to install a small pumping plant at the Knox Spring, one mile east of town or sink a large well and pump water from it into the reservoirs during the month of September. The city council has been instructed to employ a competent engineer to ascertain the cost of bringing water from Lang creek to this city and in the meantime to investigate the Knox spring and a well proposition with a view of installing a small pumping plant to put into operation at the earliest possible date.

BELLINGHAM, WASH.—E. M. George of the city engineering force, is preparing maps and blue prints of the proposed water system to be established at Silver Beach. The work will be completed in a short time and City Engineer Troutman will then submit the plans to the water board and city council. It is planned to place a concrete reservoir on the highest point in the former town of Silver Beach, at an elevation of 544 feet. The capacity of the tank will be 250,000 gallons and the water will be pumped from the lake into the reservoir.

SAN FRANCISCO, CAL.—In the expectation that there may be an early agreement with William Ham Hall over his holdings in Lake Eleanor, Clerk John Behan is preparing to sell the additional water bonds which remain from the $600,000 issue. The condemnation suit at Sonora has been delayed for two weeks, but it is expected after the trial is once begun that it will be speedily finished. It will be necessary to have the money immediately available so it can be paid at once into court when judgment is rendered if the agreement with Hall falls through.

NAPA, CAL.—The Solano-Yolo Land & Water Co. has instituted condemnation proceedings against John Brickel, N. Doane, the Canyon Cattle Co., James Phelan, T. Wassum, H. McKinzie, the Santa Fe Land Improvement Co., the Earl Fruit Co., the Bank of Yolo, etc., to condemn 3000 acres near Devils Gate, in Putah Canyon, Napa County, for a dam and reservoir site. Plaintiff, whose place of business is in San Francisco, owns the right to 1,000,000 inches of the water of Putah Creek, and to conserve water and distribute it for domestic and irrigation purposes to its Solano and Yolo County patrons wishes to raise the dam to a height of 150 feet. Defendants object, contending that their lands would be flooded.